SMART GRIDS IN CHINA: INDUSTRY REGULATION AND FOREIGN DIRECT INVESTMENT

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Synopsis: As the largest electricity consumer in the world, China is suffering from serious environmental pollution resulting from the fossil fuel dominant energy supply. Smart grid is seen as a significant way to accommodate intermittent renewable energy, increase efficiency, and cultivate energy saving, and is treated as a prioritized industry in China. China has become the world's largest market for the smart grid industry. This article analyzes China's policies on smart grids, discusses the rules on market access for foreign direct investment (FDI) in smart grid industry, and also points out the main challenges. The author finds that, although the power grid industry is still under reform and facing a lot of challenges, there are many opportunities for FDI to get involved and incentives that foreign investment can utilize to promote their smart grid business development in China.

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I. INTRODUCTION

China became the world's largest market for smart grids by investing $4.3 billion in smart grids in 2013, which accounts for more than one quarter of the

$14.9 billion spent globally.[1] Simply put, smart grids are modernized power grids integrated with information technology and other modern technologies, which enable the two-way flowing of electricity and information between power providers and consumers, increase the stability and efficiency of a power grid, and better incorporate the intermittent renewable energy to the power grids.

On November 12, 2014,[2] President Xi Jinping and President Barack Obama signed the China–U.S. Joint Announcement on Climate Change and Clean Energy Cooperation, in which China set a target to increase total energy consumption generating from zero-emission sources to around 20% by 2030. This means to meet the target, China needs to create an extra 800-1000 gigawatts of clean energy, such as solar, wind, nuclear, and other zero emission sources by 2030.[3] In order to accommodate the large amount of renewable energy into its grid, China must robustly upgrade its current grid system. Smart grids are particularly important as they not only increase the capability of the grids to integrate large-scale renewable energy, but they also enhance several other low-carbon energy technologies, including electric vehicles, distributed generation, and demand response.[4]

With the anticipation that there are great opportunities in China's smart grid industry, China is becoming the target of many foreign investors.[5] While many foreign companies are interested in the Chinese market and want to seize this huge business opportunity, their concerns are probably as great as their interest.

Although the Chinese economic reform—which started in 1978—introduced market principles into China and has changed the landscape for a lot of industries, it has much less influence on the power grid industry. This industry is traditionally under the strict control of state-owned enterprises and is still subject to the planned economy model.[6] But after President Xi Jinping took office, he carried out reforms in the electric industry to build a more market-oriented mechanism.[7] So how is the smart grid industry regulated? What is the government's attitude towards foreign direct investment in this industry?

1. *China Out-Spends the US for the First Time in $15BN Smart Grid Market*, BLOOMBERG NEW ENERGY FINANCE (Feb. 18, 2014), http://about.bnef.com/press-releases/china-out-spends-the-us-for-first-time-in-15bn-smart-grid-market/.

2. Beijing Local Time.

3. *Fact Sheet: U.S.-China Joint Announcement on Climate Change and Clean Energy Cooperation*, WHITEHOUSE.GOV (Nov. 11, 2014), http://www.whitehouse.gov/the-press-office/2014/11/11/fact-sheet-us-china-joint-announcement-climate-change-and-clean-energy-c [hereinafter *Fact Sheet*].

4. ENERGY TECH. POLICY DIV., INT'L ENERGY AGENCY, TECHNOLOGY ROADMAP: SMART GRIDS 6 (2011), *available at* http://www.iea.org/publications/freepublications/publication/smartgrids_roadmap.pdf.

5. Kamil Bojanczyk, *Reprint: China and the World's Greatest Smart Grid Opportunity*, GREENTECHMEDIA.COM (Oct. 9, 2012), http://www.greentechmedia.com/articles/read/enter-the-dragon-china-and-the-worlds-greatest-smart-grid-opportunity; Jeff St. John, *Report: China Outspent US on Smart Grid in 2013*, GREENTECHMEDIA.COM (Feb. 20, 2014), http://www.greentechmedia.com/articles/read/report-china-outspent-u.s.-on-smart-grid-in-2013; Du Juan, *State Grid's Meter Market Valued at $7.7b*, CHINA DAILY (July 8, 2011), http://www.chinadaily.com.cn/cndy/2011-07/08/content_12859519.htm.

6. Qiu Xin & Li Honglin, *Energy Regulation and Legislation in China*, 42 ENVTL. L. REP. 10678, 10684 (July 2012).

7. *Xi Jinping: Jiji Tuidong Woguo Nengyuan Shengchan he Xiaofei Geming* (习近平: 积极推动我国能源生产和消费革命) [*Xi Jinping: Actively Promoting the Revolution for Energy Production and Consumption*], XINHUANET.COM (June 13, 2014), http://news.xinhuanet.com/politics/2014-06/13/c_1111139161.htm.

The author analyzes the reasons for China's moving from a traditional power grid to a smart grid, followed by an introduction of the investment in smart grids in China (Part II); because smart grids are modernized power grids, the general regulatory mechanism over power grids still applies. The author explains the regulatory bodies, major market players, and the basic market structures (Part III) as a background for understanding the regulation over smart grids. While the government targets smart grid as a prioritized industry, policies on smart grids are spread over a lot of different documents. The author classifies and analyzes these policies (Part IV). Then the author discusses the market access and incentives for FDI in the smart grid industry (Part V) and the author explains that despite these positive policies, many challenges remain (Part VI). The final section concludes the article (Part VII).

II. FROM TRADITIONAL POWER GRIDS TO SMART GRIDS IN CHINA

A. Definition of Smart Grids

Although the term "smart grid" is widely used, as the International Energy Agency (IEA) explains, smart grid evolves with the development of technologies and it is adjusted to fit into the system of every country or region.[8]

Nonetheless, there are some common features defining the scope of smart grids. Generally speaking, a smart grid is a modernized electricity network that integrates information, communication, and other advanced technologies to realize the two-way flow of electricity and information between the power plants and consumers and all points in between[9] In contrast to traditional power grids, smart grids have the following advantages: they (1) are able to accommodate large-scale intermittent renewable energy, and distributed energy generation; (2) enable peak-shaving and energy saving by demand response, energy storage, plug-

8. ENERGY TECH. POLICY DIV., *supra* note 4. According to the U.S. Department of Energy (DOE), the utilization of two-way communication and computer processing technologies to realize remote control and automation in power grids is the cornerstone of smart grid. "Smart Grid", says DOE represents a class of technology people are using to upgrade utility electricity delivery systems, using computer-based remote control and automation. "These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses". *Smart Grid*, ENERGY.GOV, http://energy.gov/oe/services/technology-development/smart-grid (last visited December 26, 2014). The European Union views smart grid as "an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it—generators, consumers and those that do both—in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety". Smart grid also depends on the employment of "innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies". *Commission Staff Working Document, Definition, Expected Services, Functionalities and Benefits of Smart Grids*, at 2, SEC (2011) 463 final (Apr. 12 2011), *available at* http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011SC0463&from=EN. Compared to the approach of other countries, Japan endeavors to build a comprehensive smart grid, called Nature Grid. The target is to build a comprehensive system including smart offices, smart schools, smart houses, smart factories, and smart stores. Amy Poh Ai Ling et al., *The Japanese Smart Grid Initiatives, Investments, and Collaborations*, 3 INT'L J. ADVANCED COMPUTER SCI. & APPLICATIONS, NO. 7, at 1, 2.

9. *See generally* OFFICE OF ELEC. TRANSMISSION AND DISTRIB., U.S. DEP'T OF ENERGY, "GRID 2030": A NATIONAL VISION FOR ELECTRICITY'S SECOND 100 YEARS (2003), *available at* http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/Electric_Vision_Document.pdf.

in and hybrid electric vehicles, and other technologies; and (3) increase the reliability and efficiency of electricity transmission and distribution. In respect to their scope, smart grids generally include electricity networks (transmission and distribution systems) and interface with generation, storage, and end-users.[10]

Smart grid in China is sometime referred to as "Strong Smart Grid."[11] The concept of Strong Smart Grid was introduced by the State Grid Corporation of China (SGCC),[12] which serves about 88% of the area of China.[13] The SGCC has declared that the modernized grid system of China should be both "strong" and "smart". As concerns "strong," it means that the power grid should have strong networks capable of transmitting large amounts of electricity over a long distance both safely and stably. The SGCC makes Ultra High Voltage transmission the priority when building a "strong" grid.[14] But this approach is controversial and has been questioned.[15] With regard to "smart," this refers to those features commonly known as smart grid and aims for this to penetrate into every aspect of grid improvement.[16]

Although "strong" and "smart" are closely related, they refer to different aspects of the grid. In official documents of the government, "strong" and "smart" are always stated and dealt with separately.[17] This article mainly focuses on the regulation concerning the "smart" aspect of the grid in China.

10. ENERGY TECH. POLICY DIV., *supra* note 4.

11. 坚强智能电网 (*Jianqiang Zhineng Dianwang*). In the SGCC's General Plan on Application of Intelligent Technologies to Power Grids, Strong Smart Grid is defined as modernized power grids with the characteristics of digitalization, automation, and interactiveness, based on the strong power networks consisting of Ultra High Voltage transmission grids as its backbone and the concurrently developed various levels of grids, which are supported by a telecommunication information platform. Strong Smart Grid incorporates generation, transmission, transformation, distribution, utilization, and dispatch, covers all levels of voltage, and greatly integrates the electricity flow, information flow, and business flow. GUOJIA DIANWANG GONGSI (国家电网公司) [STATE GRID CORP. OF CHINA], GUOJIA DIANWANG ZHINENGHUA GUIHUA ZONGBAOGAO (XIUDINGGAO) (国家电网智能化规划总报告(修订稿)) [GENERAL PLAN ON APPLICATION OF INTELLIGENT TECHNOLOGIES TO POWER GRIDS (REVISED VERSION)] 34 (Mar. 2010) [hereinafter GENERAL PLAN].

12. *Liu Zhenya zai Zhineng Dianwang Guoji Luntan Zuo Zhuzhi Fayan* (刘振亚在智能电网国际论坛作主旨发言) [*Liu Zhenya's Keynote Speech at International Forum of Smart Grids*], YINGDA WANG (英大网) [INDAA.COM.CN] (Sept. 28, 2011), http://www.indaa.com.cn/dwxw2011/zndw/201109/t20110928_786861.html.

13. Gongsi Jianjie (公司简介) [*Introduction to the Corporation*], STATE GRID CORP. OF CHINA, http://www.sgcc.com.cn/gsjs/gsjj/default.shtml (last visited June 5, 2015).

14. GENERAL PLAN, *supra* note 11, at 34-35, 38-40.

15. Yao Yao (姚尧), *Jiaoliu Tegaoya Zhengyizhong Shangma* (交流特高压争议中上马) [*Alternating Current Ultra High Voltage Transmission Projects Being Launched Although There Are Disputes*], 518 ZHONGGUO JINGJI XINXI (中国经济信息) [ECONOMIC INFORMATION OF CHINA] 54, 55 (2014).

16. *See generally* GENERAL PLAN, *supra* note 11.

17. *See, e.g.*, Zhonghua Renmin Gongheguo Guomin Jingji he Shehui Fazhan Dishi'erge Wunian Guihua Gangyao (中华人民共和国国民经济和社会发展第十二个五年规划纲要) [The 12th Five-year Plan for National Economic and Social Development State Council of China] (promulgated by the 4th Session of the 11th Nat'l People's Cong., Mar. 14, 2011), ch. 10, § 1 and ch. 11, § 3, *available at* http://www.gov.cn/2011lh/content_1825838.htm [hereinafter 12th FYP]; Guowuyuan Guanyu Yinfa Nengyuan Fazhan "Shi'erwu" Guihua de Tongzhi" (国务院关于印发能源发展"十二五"规划的通知) [Notice of the State Council on Issuing the 12th Five-year Plan on Energy Development] (promulgated by the State Council, Jan. 1, 2013), *available at* http://www.gov.cn/zwgk/2013-01/23/content_2318554.htm [hereinafter 12th FYP on Energy Development].

In its 12th Five-year Specialized Plan on the Industrialization of Key Sciences and Technologies of Smart Grids,[18] China's Ministry of Science and Technology (MOST) listed nine key aspects of smart grid technologies that the Chinese government plans to promote. These key aspects included: (1) the integration of large-scale intermittent renewable energy; (2) grid technologies to support the development of electric vehicles; (3) large-scale energy storage technologies; (4) smart electricity distribution and utilization technologies; (5) the operation and control of a large-scale power grid; (6) smart electricity transmission and transformation technologies and equipment; (7) grid information and communication technologies; (8) flexible transmission and transformation technologies and equipment; and (9) comprehensive pilot projects of integrated smart grids.[19]

B. Reasons for China's Transition to Smart Grids

China became the largest electricity market in the world in 2011.[20] The annual electricity generation[21] of China reached 5361.6 TWH in 2013, which accounts for 23.2% of the world's total production.[22] The electricity generating capacity also reached 1.25 TW in 2013, placing China at the top of the worldwide generating capacity list for the first time.[23]

However, China is the largest coal consuming country in the world, accounting for half of the world's coal consumption.[24] Coal is a cheap and abundant energy source that has supported the industrialization of modern China. It has deeply penetrated into the Chinese society—66% of the energy supply in China was generated from coal in 2014.[25] The State Council of China requires the reduction of the consumption of coal and limits the proportion of coal generated

18. Guanyu Yinfa Zhineng Dianwang Zhongda Keji Chanyehua Gongcheng "Shi'erwu" Zhuanxiang Guihua de Tongzhi (关于印发智能电网重大科技产业化工程"十二五"专项规划的通知) [The 12th Five-year Specialized Plan on the Industrialization of Key Sciences and Technologies of Smart Grids] (promulgated by Ministry of Science and Technology (MOST), Mar. 27, 2012), *available at* http://www.most.gov.cn/tztg/201205/t20120504_94114.htm [hereinafter 12th FYSP on the Industrialization of Key Sciences and Technologies of Smart Grids].

19. *Id.* at 9-21.

20. *International Energy Statistics*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=2&pid=2&aid=12 (last visited June 5, 2015).

21. Based on gross output.

22. United States ranked second with production of 4260.4 TWh, accounting for 18.4% of the world's production. BRITISH PETROLEUM, BP-STATISTICAL REVIEW OF WORLD ENERGY (2014). Data is slightly different in various sources, but within small margins and does not change the analytical results. *See also* INT'L ENERGY AGENCY, KEY WORLD ENERGY STATISTICS (2014), *available at* http://www.iea.org/publications/freepublications/publication/KeyWorld2014.pdf (last visited Dec. 19, 2014).

23. *Zhongdianlian Fabu 2014 Niandu Dianli Gongxu Xingshi Fenxi Yuce Baogao* (中电联发布 2014 年度全国电力供需形势分析预测报告) [*China Electricity Council (CEC) Published Report on Analysis and Prediction of National Electricity Supply and Demand]*, ZHONGGUO DIANLI QIYE LIANHEHUI (中国电力企业联合会) [CHINA ELEC. COUNCIL] (Feb. 25, 2014), http://www.cec.org.cn/guihuayutongji/gongxufenxi/dianligongxufenxi/2014-02-25/117272.html.

24. BRITISH PETROLEUM, *supra* note 22, at 33.

25. GUOJIA TONGJI JU (国家统计局) [NATIONAL BUREAU OF STATISTICS OF CHINA], http://data.stats.gov.cn/easyquery.htm?cn=C01 (last visited Jan. 4, 2016).

consumption to 62% by 2020.[26] The resulting pollution and greenhouse gas emission problems are serious. The tension between increasing electricity consumption and environment protection is escalating. It is crucial for China to increase the proportion of clean energy production, while promoting energy saving, reducing energy consumption, and improving energy efficiency.[27]

On November 12, 2014, President Xi Jinping and President Barack Obama signed the China—U.S. Joint Announcement on Climate Change and Clean Energy Cooperation in which China set a target to increase the level of total energy consumption generated from zero-emission sources to around 20% by 2030. This means that China needs to create an extra 800-1000 gigawatts of clean energy, such as solar, wind, nuclear, and other zero-emission sources by 2030.[28]

The existing power grids in China cannot support the rapid growth of clean energy.[29] The connection of large amounts of intermittent renewable energy into the power grids raises new challenges to the planning, dispatch, operation, and security of the power grids.[30] In order to accommodate the large amount of renewable energy into grids, China must robustly upgrade its current grid system.

The multiple demands of grid customers raise additional challenges. For example, the connection of distributed energy, charging and discharging of electric vehicles, and two-way communication between grid and consumers to introduce demand side management and increase efficiency.[31] These requirements are beyond the capacity of traditional grids.

Smart grids are seen as a way to respond to these challenges by reducing energy consumption, increasing the efficiency of the electricity network, and managing electricity generated from renewables.[32]

Additionally, the pressure to guarantee the safe and stable operation of giant power grids is huge.[33] The development of the grid requires an advance in key technologies and equipment. Power utilities need to introduce smart transmission and transformation equipment that is able to realize lifecycle management and increase the utilization of assets, while increasing safety and efficiency with low maintenance fees. The interactive communication between smart transmission equipment and control centers facilitates dynamic adjustment of grid operation

26. Guowuyuan Bangongting Guanyu Yinfa Nengyuan Fazhan Zhanlue Xingdong Jihua (2014- 2015 Nian) (国务院办公厅关于印发能源发展战略行动计划 (2014-2020 年)) [Notice of the General Office of the State Council on Issuing the Strategic Action Plan on Energy Development (2014-2020)] (promulgated by the General Office of the State Council, Guobanfa [2014] 31 Hao, June 7, 2014), *available at* http://www.gov.cn/zhengce/content/2014-11/19/content_9222.htm [hereinafter Strategic Action Plan on Energy Development].

27. 12th FYSP on the Industrialization of Key Sciences and Technologies of Smart Grids, *supra* note 18, at 5.

28. *Fact Sheet*, *supra* note 3.

29. 12th FYSP on the Industrialization of Key Sciences and Technologies of Smart Grids, *supra* note 18, at 4.

30. *Id.* at 5.

31. *Id.*

32. ENERGY TECH. POLICY DIV., *supra* note 4, at 21.

33. 12th FYSP on the Industrialization of Key Sciences and Technologies of Smart Grids, *supra* note 18, at 5.

and increases grid stability.[34] Therefore, China has placed smart grid as a prioritized industry in several top-leveled documents.[35]

C. Investment in Smart Grids in China

China became the world's largest market for smart grids by investing $4.3 billion in smart grids in 2013, which accounts for more than one-quarter of the $14.9 billion spent globally.[36] A large part of that sum went into the installation of 62 million smart meters.[37] The total amount of smart meters in China was about 250 million as reported on February 18, 2014, which was more than twice the total number of households in the United States.[38]

According to the SGCC's plan, it will invest RMB3.45 trillion (about USD556 billion) from 2009 to 2020, 11.1% of which—RMB384.1 billion (about USD62 billion)—will be spent on grid intelligent technologies.[39] This massive investment, along with the ambitious targets set by the Chinese Government for deployment of renewable energy technologies, energy efficiency improvements,[40] and smart grids, presents opportunities for FDI in China.

China is becoming the target of many foreign investors in smart grids,[41] for example, General Electric,[42] Siemens,[43] ABB,[44] and several other enterprises are cooperating with domestic Chinese partners to expand their smart grid business in China.[45]

34. *Id.*

35. 12th FYP, *supra* note 17; Guojia Nengyuanju Guanyu Yinfa Guojia Nengyuan Keji "Shi'erwu" Guihua de Tongzhi (国家能源局关于印发国家能源科技"十二五"规划的通知) [Notice of the NEA on Issuing the 12th Five-year Plan on National Energy Science and Technology] (promulgated by NEA, Guoneng Keji [2011] 395 Hao, Dec. 5, 2011), *available at* http://www.gov.cn/gzdt/2012-02/10/content_2063324.htm [hereinafter 12th FYP on National Energy Science and Technology]; 12th FYP on Energy Development, *supra* note 17; Strategic Action Plan on Energy Development, *supra* note 26.

36. *China Out-Spends the US for the First Time in $15BN Smart Grid Market*, *supra* note 1.

37. *Id.*

38. *Id.* This number has been increasing rapidly. Although the total sum for smart meters installed in China by now is unavailable, it was reported that SGCC alone had installed 317 million smart meters in total by the end of 2015. Guojia Dianwang: 2015 Nian Guojian Dianwang Shouzhi Bili Gaoda 4 Bei (国家电网：2015 年国建电网收支比例高达 4 倍) [State Grid Corp. of China: Income is Four Times Expenses in 2015], OFWEEK.COM (Jan. 18, 2016), http://smartgrids.ofweek.com/2016-01/ART-290017-8420-29055604.html.

39. GENERAL PLAN, *supra* note 11, at 215.

40. ENERGY AND SEC. GRP., INT'L TRADE ADMIN., U.S. DEP'T OF COMMERCE, CLEAN ENERGY: AN EXPORTER'S GUIDE TO CHINA 36 (2008), *available at* http://trade.gov/media/publications/pdf/china-clean-energy2008.pdf.

41. Bojanczyk, *supra* note 5; St. John, *supra* note 5; Du, *supra* note 5.

42. Matt Lecar, Principal, GE Energy Consulting, Address at the USTDA Webinar: China Smart Grid Standards (Feb. 12, 2013).

43. St. John, *supra* note 5.

44. Women de Gongsi (我们的公司) [*Our Company*], YANGZHOU GUODIAN NANZI KAIGUAN YOUXIAN GONGSI (扬州国电南自开关有限公司) [YANGZHOU SAC SWITCHGEAR CO., LTD.], http://www.sac-switchgear.com/index.aspx.

45. St. John, *supra* note 5.

III. CHINA'S POWER GRID REGULATORY MECHANISM

Energy regulation in China was subject to the planned economy model after the establishment of the People's Republic of China.[46] In 1996, the State Power Corporation of China was established. It was a solely state-owned enterprise in charge of providing electricity across regions and managing the state grid system.[47] It followed the vertically integrated industry model, and owned most of China's power generation industry and almost all the power grids across China.[48]

The current power industry structures were formed in 2002. "[B]ased on the principle of separation of electricity [generation] and transmission, China reorganized the State Power Corporation [and] set up independent electricity producers . . . ."[49] "All operations under the State Power Corporation were divided into two types of businesses: electricity [generation]; and electricity grid. Five independent electricity-[generating] enterprises were set up . . . ."[50]

The primary legislation regulating the power sector is the Electric Power Law of the People's Republic of China.[51] It was enacted in December 1995 and established the basic principles.[52] Currently, however, the provisions of this legislation are too general and many of them are out of date. The statute does not provide for the regulatory bodies over the electric power industry, and does not specify who is qualified to be a public utility generating or transmitting electricity. Although the Electric Power Law was revised in 2015, the Standing Committee of National People's Congress deleted just one paragraph and did not touch other articles.[53] A draft of China's integrated Energy Law was published in 2007,[54] but the draft has not been passed.

The State Council of China can pass administrative regulations, decisions, and orders, within their power authorized by the Constitution and law[55] when law,

46. Qiu & Li, *supra* note 6, at 10678.

47. Guojia Dianli Gongsi Zhangcheng (国家电力公司章程) [Articles of Association of State Power Corporation of China], art. 4, in Guowuyuan Guanyu Zujian Guojia Dianli Gongsi de Tongzhi (国务院关于组建国家电力公司的通知) [Notice of the State Council on Establishing the State Power Corporation of China] (promulgated by the Office of the Program on Establishing the State Power Corporation of State Commission Office of Public Sectors Reform and Ministry of Electric Industry, Guofa [1996] 48 Hao, Dec. 7, 1996).

48. *Id.*

49. Qiu & Li, *supra* note 6, at 10682.

50. *Id.*

51. Zhonghua Renmin Gongheguo Dianli Fa (中华人民共和国电力法) [Electric Power Law of People's Republic of China] (Promulgated by the 17th Session of the Standing Comm. of the 8th Nat'l People's Cong., Dec. 28, 1995, effective Apr. 1, 1996, revised on Aug. 27, 2009 and Apr. 24, 2015), *available at* http://www.gov.cn/ztzl/2005-12/30/content_142165.htm [hereinafter Electric Power Law].

52. *Id.*

53. Quanguo Remin Daibiao Dahui Changwu Weiyuanhui Guanyu Xiugai "Zhonghua Renmin Gongheguo Dianlifa" Deng Liubu Falü de Jueding (全国人民代表大会常务委员会关于修改《中华人民共和国电力法》等六部法律的决定) [Decision of the Standing Committee of National "People's Congress on Revision of six laws including Electric Power Law" of the People's Republic of China] (passed by the 14th session of the Standing Comm. of the 12th Nat'l People's Cong., Apr. 24, 2015), *available at* http://www.npc.gov.cn/npc/cwhhy/12jcwh/2015-04/25/content_1934598.htm.

54. Zhonghua Renming Gongheguo Nengyuanfa (Zhengqiu Yijian Gao) (中华人民共和国能源法(征求意见稿)) [Energy Law of the People's Republic of China (Draft for Comment)] (Dec. 4, 2007), *available at* http://news.xinhuanet.com/fortune/2007-12/04/content_7195580.

55. Zhonghua Renmin Gongheguo Xianfa (中华人民共和国宪法) [Constitution of the People's Republic of China] (promulgated by the 5th Nat'l People's Cong., Dec. 4, 1982, effective Dec. 4, 1982, revised on Apr. 12,

which is passed by the National People's Congress or its standing committee, is too general or silent on certain problems. In practice, many problems are dealt with by administrative regulations, decisions, and orders.

Another feature of China's Power Grid Regulatory Mechanism is that regulatory powers are concentrated in the central government. Unlike in the United States, where division of power between federal government and state governments over electric industry regulation is a key issue, this question does not exist in China. The State Council of China is authorized to lead local administrative organs. The detailed functions and powers of provincial administrative organs are formulated by the State Council.[56] Most of the regulatory powers over power grids belong to central government or its departments, from power grid development planning, to approval of major power grids construction projects, to electricity rates (including wholesale and retail rates).

A. Regulatory Bodies

The energy regulatory bodies in China have been changing frequently, from a unified energy-supervising agency to separated industry regulation by energy sector (coal, electricity, oil, etc.), then back to unified regulation again.[57] The latest change happened in 2013. The State Electricity Regulatory Commission (SERC)[58] was dissolved and its functions were incorporated into the National Energy Agency (NEA). Currently, the power industry regulatory bodies are the National Energy Commission (NEC), the National Development and Reform Commission (NDRC), and the NEA.[59]

1988, Mar. 29, 1993, Mar. 15, 1999 and Mar. 14, 2004), art. 89, § 1 (1982) (China), *available at* http://www.gov.cn/test/2005-06/14/content_6310.htm. The Standing Committee of National People's Congress has the power to annul those administrative regulations, decisions or orders of the State Council that contravene the Constitution or law. *Id.* at art. 67, § 7 (1982). But the legality of administrative regulations, decisions and orders with general binding force formulated and announced by administrative organs cannot be challenged in court, unless it is raised together with a suit against specific actions taken by the administrative organs according to the rule in dispute. Zhonghua Renmin Gongheguo Xingzheng Susong Fa (中华人民共和国行政诉讼法) [Admistrative Procedure Law of the People's Republic of China] (promulgated by the 2nd Session of the 7th Nat'l People's Cong., Apr. 4, 1989, effective Oct. 1, 1990, revised by the 11th session of the Standing Comm. of the 12th Nat'l People's Cong., Nov. 1, 2014), art. 13, § 2, art. 53, *available at* http://www.npc.gov.cn/wxzl/gongbao/2014-12/23/content_1892467.htm.

56. Xianfa, art. 89, § 4 (1982) (China).

57. Chen Liuqin (陈柳钦), Zhongguo Nengyuan Guanli Tizhi "Guaiquan" Ruhe Po? Chengli Gaojibie Xietiao yu Juece Jigou Buke Bimian (中国能源管理体制"怪圈"如何破？成立高级别协调与决策机构不可避免) [How to Break the Vicious Circle of Energy Mechanism? It Is Inevitable to Establish High-level Coordinating and Decision-making Body], HUAXIA NENGYUAN WANG (华夏能源网) [SINOERGY.COM] (Sept. 16, 2014), http://www.sinoergy.com/陈柳钦/8336/.

58. Guowuyuan Jigou Gaige he Zhineng Zhuanbian Fang'an (国务院机构改革和职能转变方案) [The Program for Organizational Reform and Functional Transformation of the State Council] (promulgated by the 1st Session of the 12th Nat'l People's Cong., Mar. 14, 2013), *available at* http://www.gov.cn/2013lh/content_2354443.

59. Except for those, other departments also have some energy regulation functions, such as Ministry of Land and Resources, Ministry of Housing and Urban-Rural Development, State Administration of Work Safety, Ministry of Commerce, Ministry of Environmental Protection, and State Bureau of Tax; *see generally* Qiu & Li, *supra* note 6.

1. National Energy Commission (NEC)

The NEC was established in 2010. It is the highest-level organization specifically in charge of energy regulation. The Premier and Vice-Premier of the State Council are the director and vice-director respectively of the Commission. The Commission is in charge of: setting up the national energy development strategies; examining major problems on energy security and energy development; coordinating major issues concerning domestic energy exploration; and international energy cooperation.[60] Its office is set in the NEA.

2. National Development and Reform Commission (NDRC)

The NDRC is the major government body responsible for macroeconomic regulation.[61] With respect to the power grid, the NDRC performs regulatory functions, including but not limited to approval powers for major projects on behalf of the State Council and price setting authority for the generation price, transmission and distribution price, and retail price of electricity.[62]

3. National Energy Administration (NEA)

The NEA is overseen by the NDRC.[63] After the incorporation of SERC, the NEA not only has administrative regulatory power, but is also in charge of electricity market supervision.[64] It is a comprehensive body with regulatory power over coal, oil, natural gas, electricity, renewable energy, nuclear power, and other energy sources. With regard to electricity, the NEA is mainly in charge of drafting plans for energy development, examining and approving power projects, and supervising the operation of power markets.[65] However, the NEA does not

60. Guowuyuan Bangongting Guanyu Chengli Guojia Nengyuan Weiyuanhui de Tongzhi (国务院办公厅关于成立国家能源委员会的通知) [Notice of the General Office of the State Council on the Establishment of National Energy Commission] (promulgated by the General Office of the State Council, Guobanfa [2010] 12, Jan. 22, 2010), *available at* http://www.gov.cn/zwgk/2010-01/27/content_1520724.htm.

61. Guowuyuan Bangongting Guanyu Yinfa Guojia Fazhan he Gaige Weiyuanhui Zhuyao Zhize Neishe Jigou he Renyuan Bianzhi de Tongzhi (国务院办公厅关于印发国家发展和改革委员会主要职责内设机构和人员编制规定的通知) [Notice of the General Office of the State Council on Issuing the Provisions on the Main Functions, Internal Bodies and Staffing of the NDRC] (promulgated by the General Office of the State Council, Guobanfa [2008] 102 Hao, July 15, 2008), *available at* http://zfxxgk.ndrc.gov.cn/PublicItemView.aspx?ItemID={2050a9f4-cd8e-41de-836e-e2ea2a9950d5} [hereinafter Provisions on the Main Functions, Internal Bodies and Staffing of the NDRC].

62. *Id.*; Electric Power Law, *supra* note 51, art. 38, 39, 40; Shupei Dianjia Guanli Zanxing Banfa (输配电价管理暂行办法) [Provisional Measures on the Management of Power Transmission and Distribution Price] art. 3 (attached to Guojia Fazhan Gaige Weiyuanhui Guanyu Yinfa Dianjia Gaige Shishi Banfa de Tongzhi (国家发展改革委关于印发电价改革实施办法的通知) [Notice of the NDRC on Measures for the Implementation of Electricity Price Reform] (promulgated by NDRC, Mar. 28, 2005, effective May 1, 2005), *available at* http://bgt.ndrc.gov.cn/zcfb/200506/t20050613_499539.html).

63. *See generally* Provisions on the Main Functions, Internal Bodies and Staffing of the NDRC, *supra* note 61.

64. *See generally id.*

65. Guowuyuan Bangongting Guanyu Yinfa Guojia Nengyuanju Zhuyao Zhize Neishe Jigou he Renyuan Bianzhi Guiding de Tongzhi (国务院办公厅关于印发国家能源局主要职责内设机构和人员编制规定的通知) [Notice of the General Office of the State Council on Issuing the Provisions on the Main Functions, Internal Bodies and Staffing of the National Energy Agency (NEA)] (promulgated by the General Office of the State Council, Guobanfa [2013] 51 Hao, June 9, 2013), *available at* http://www.gov.cn/zwgk/2013-06/19/content_2428974.htm.

have final authority in many areas such as major planning, major power projects, and matters involving the price of electricity. In such matters, the NEA can only make suggestions to the NDRC, which then takes the final decision.[66]

B. Major Market Players

The responsibility for generation and transmission formerly held by the State Power Corporation was separated in 2002.

1. Power Generation

After the reorganization of the State Power Corporation in 2002, five independent electricity producers were set up.[67] They are: China Huaneng Corporation; China Huadian Corporation; China Power Investment Corporation; China Guodian Corporation; and China Datang Corporation.[68]

Beside the five large power producers and the SGCC, local government corporations, quasi-private, and private companies make up just over half of China's total generation capacity.[69]

2. Power Grids

The grid systems were reorganized into two grid companies: the SGCC and China South Power Grid (CSG). The State-owned Assets Supervision and Administration Commission of the State Council (SASAC) is responsible for investor functions over both the SCGG and the CSG.[70]

The SGCC is the largest public utility company in China, serving more than 1.1 billion people. It is composed of five regional grid systems: Northern China; Northeastern China; Northwestern China; Eastern China; and Central China, which together cover twenty-six provinces, autonomous regions, and municipalities, accounting for about 88% of the area of China.[71] CSG serves Southern China, which consists of five provinces.[72] In addition, there is the Inner Mongolia Power (Group) Co. Ltd. It is owned by the local government and serves

66. *Id.*

67. Qiu & Li, *supra* note 6, at 10682.

68. Dianli Tizhi Gaige Fang'an (电力体制改革方案) [Program on Electric Mechanism Reform] (promulgated by the State Council, Guofa [2002] 5 Hao, Feb. 10, 2002) [hereinafter Program on Electric Mechanism Reform].

69. REGULATORY ASSISTANCE PROJECT, CHINA'S POWER SECTOR: A BACKGROUNDER FOR INTERNATIONAL REGULATORS AND POLICY ADVISORS 4 (2008), *available at* http://www.raponline.org/document/download/id/13.

70. Yangqi Minglu (央企名录) [Catalogue of the Central Level State-Owned Enterprises], STATE-OWNED ASSETS SUPERVISION AND ADMINISTRATION COMM'N OF THE STATE COUNCIL (SASAC) (Feb. 9, 2015), http://www.sasac.gov.cn/n86114/n86137/c1725422/content.html.

71. Gongsi Jianjie, *supra* note 13.

72. Nanwang Jianjie (南网简介) [Introduction to China South Power Grid (CSG)], CHINA S. POWER GRID, http://www.csg.cn/gynw/ (last visited June 5, 2015).

part of the Inner Mongolia Autonomous Region.[73] All of these grid companies are state-owned enterprises.[74]

C. *Market Structure*

"The reforms of 2002 put in place an industry structure that can be characterized as a single-buyer purchasing agency model."[75]

Power transmission, distribution, and retailing are all vertically integrated and owned by the power grid companies.[76] In each region, multiple generating companies sell power to the monopoly grid companies, typically the provincial grid companies. These grid companies then re-sell power to consumers under government-approved retail prices. For the most part, generation is sold under wholesale contracts at prices approved by the NDRC.[77] The grid companies earn their profits from the difference between the cost of buying and the revenue from selling power.

In order to introduce competition, China is promoting direct power transactions between generators and large customers. The NDRC also launched pilot projects in Shenzhen, the Inner Mongolia Autonomous Region, and five other provinces.[78] Under this trial model, grid companies only charge for the service of transmission and distribution, leaving the retailing price to market competition.[79]

IV. SMART GRID DEVELOPMENT AND POLICY IN CHINA

The unique characteristics of China's power grid has led to the adoption of a different approach by China to promote smart grid development in which government and grid companies play a major part.

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73. Gongsi Jianjie (公司简介) [Introduction to the Corporation], INNER MONGOLIA POWER (GROUP) CO., LTD, http://www.impc.com.cn (last visited June 5, 2015).

74. State-owned enterprise in China represents not only central-government-owned but also local-government-owned enterprises. In addition, there are some independent grid companies in China. Most of them are State-owned or State-controlled enterprises, but some of them have more complicated capital structures.

75. REGULATORY ASSISTANCE PROJECT, *supra* note 69, at 3.

76. *Id.* at 5.

77. *Id.*

78. Anhui, Hubei, Ningxia, Yunnan, and Guizhou Provinces. Guojia Fazhan Gaigewei Guojia Nengyuanju Guanyu Yinfa Dianli Tizhi Gaige Peitao Wenjian de Tongzhi (国家发展改革委 国家能源局关于印发电力体制改革配套文件的通知) [Supporting Documents on the Electric Power Mechanism Reform] (promulgated by the NDRC and NEA, Fagai Jingti [2015] 2752 Hao, Nov. 26, 2015), app. 1, *available at* http://www.ndrc.gov.cn/fzgggz/tzgg/zhdt/201511/t20151130_760139.html [hereinafter Supporting Documents on the Electric Power Mechanism Reform].

79. Guojia Fazhan Gaigewei Guanyu Shenzhenshi Kaizhan Shupei Dianjia Gaige Shidian de Tongzhi (国家发展改革委关于深圳市开展输配电价改革试点的通知) [Notice of the NDRC on Launching a Pilot Project on Power Transmission and Distribution Price Reform in Shenzhen] (promulgated by NDRC, Fagai Jiage [2014] 2379 Hao, Oct. 23, 2014, effective Jan. 1, 2015), *available at* http://www.sdpc.gov.cn/fzgggz/jggl/zcfg/201411/t20141104_639669.html [hereinafter Notice of the NDRC on Launching a Pilot Project on Power Transmission and Distribution Price Reform in Shenzhen]; Neimenggu Chengwei Quanguo Dierge Shupei Dianjia Gaige Shidian Diqu (内蒙古成为全国第二个输配电价改革试点地区) [Inner Mongolia Autonomous Region Became the Second Pilot Area in China for Power Transmission and Distribution Price Reform], NAT'L DEV. AND REFORM COMM'N (Jan. 27, 2015) , http://dbzxs.ndrc.gov.cn/dbzx/201501/t20150127_662392.html [hereinafter Inner Mongolia Autonomous Region Became the Second Pilot Area in China for Power Transmission and Distribution Price Reform].

Administrative regulations and policies, combined with the documents developed by grid companies, form smart grid rules and incentives. These rules can be very complex because, currently, there is no established process to coordinate the different sets of regulations, and because smart grids themselves are huge systems. In this part, the author analyzes these scattered rules and attempts to provide a clearer picture of smart grid policies in China.

A. General Rules

Several high-level documents have mapped out the general policies on smart grid regulation in China. The 12th Five-year Plan for National Economic and Social Development (12th FYP) identified the smart grid as one of the strategic emerging industries.[80] Subsequently, the 12th Five-year Plan on Energy Development,[81] and the Strategic Action Plan on Energy Development (2014-2020)[82] both highlighted the importance of smart grids. The NEA,[83] MOST,[84] SGCC,[85] and CSG[86] each laid out specific policies and guidelines on smart grid technology development. In response to the need for policies to facilitate the healthy development of smart grids, NDRC and NEA jointly published The Guideline on Promoting Development of Smart Grid.[87] Meanwhile, the standardization of smart grid technologies is being actively carried out on all levels, namely enterprise, industrial, national, and international standards.

1. Strategic Targets: Strong and/or Smart Grid

The Chinese government adopts a comprehensive planning system to establish strategic development for the country. At the top of this system is the Five-year Plan for National Economic and Social Development, which as its name suggests, is formulated every five years and is the most important disclosure of the strategic development blueprint for China.[88] The 12th FYP, covering the

80. 12th FYP, *supra* note 17, ch. 10, § 1.

81. 12th FYP on Energy Development, *supra* note 17.

82. Strategic Action Plan on Energy Development, *supra* note 26.

83. 12th FYP on National Energy Science and Technology, *supra* note 35.

84. 12th FYSP on the Industrialization of Key Sciences and Technologies of Smart Grids, *supra* note 18.

85. GENERAL PLAN, *supra* note 11.

86. Jiahai Yuan et al., *Smart grids in China*, 37 RENEWABLE AND SUSTAINABLE ENERGY REVIEWS 896, 901 (2014).

87. Guojia Fazhan Gaigewei Guojia Nengyuanju Guanyu Cujin Zhineng Dianwang Fazhan de Zhidao Yijian (国家发展改革委 国家能源局关于促进智能电网发展的指导意见) [The Guideline on Promoting Development of Smart Grid] (promulgated by the NDRC and NEA, Fagai Yunxing [2015] 1518 Hao, July 6, 2015) NAT'L DEV. AND REFORM COMM'N (2015), *available at* http://www.sdpc.gov.cn/gzdt/201507/t20150706_736625.html [hereinafter The Guideline on Promoting Development of Smart Grid].

88. The five-year plans of People's Republic of China are a series of documents containing detailed guidelines for almost all the social and economic sectors of the Country. They are formulated every five years and are the most important documents reflecting the strategic development blueprint of China. The latest one is the 13th FYP posted on March 17, 2016, which covers the period of 2016 to 2020. (Zhonghua Renmin Gongheguo Guomin Jingji he Shehui Fazhan Dishisange Wunian Guihua Gangyao (中华人民共和国国民经济和社会发展第十三个五年规划纲要) [The 13th Five-year Plan for National Economic and Social Development State Council of China] (promulgated by the 4th Session of the 12th Nat'l People's Cong., Mar. 16, 2016), *available at* http://news.xinhuanet.com/politics/2016lh/2016-03/17/c_1118366322.htm) But it will take some time for the relevant departments to publish supporting documents carrying out this plan, considering that some

period from 2011 to 2015, lists smart grid as one of the key areas of the Strategic Emerging Industries,[89] which enjoys preferential treatment.[90]

While debates are still going on about whether strong or smart grid should be the priority for grid development in China, the central government adopts the approach of confirming the importance of both. The author takes a closer look at the nationwide plans concerning the construction of the power grid, including the 12th FYP, the 12th Five-year Plan on Energy Development, the 12th Five-year Plan on National Energy Science and Technology (2011-2015), and the Strategic Action Plan on Energy Development (2014-2020). On one hand, the plans require the expansion of the size of west-to-east (some also the north-to-south) power transmission facilities and the development of large-capacity, high efficiency, and long-distance power transmission technologies, namely the Ultra High Voltage transmission.[91] On the other hand, the plans emphasize the need for construction of smart grids to improve the operation and supply reliability of the power grid by utilizing advanced information, control, and energy storage technologies.[92] As to the generation of renewable energy, the central government has expressed a clear preference that both centralized and distributed generation should be developed.[93] It seems clear that strong and smart grid technology represents the future direction for power grid improvements in China. The Guideline on Promoting Development of Smart Grid, expressly points out that the centralized long distance

of the supporting documents for the 12th FYP did not be published until two years later. The 13th FYP is consistent with the 12th FYP regarding those aspects mentioned in this article. It still locates smart grid industry as one of the Strategic Emerging Industries, and deems smart grid development as an important way to upgrade its grid system. (ch. 23) It also values both long distance transmission and distributed generation. (ch. 30) For the purpose of this article, the author cited the 12th FYP to avoid confusion. Because further plans available for now regarding smart grids are still those implementing the 12th FYP. As the 12th and 13th FYP is consistent with each other with respect to smart grids, these policies are still of great value. It is worth mentioning that beside smart grids, the Chinese government shows great interest in energy storage and distributed generation in the 13th FYP. (ch. 23, 30) It is also more mature in promoting smart grids, and raises the concept of Smart Energy System. For this point, the author hereby translated the relevant text of 13th FYP for readers who are interested:

> § 3 Endeavor to Build Smart Energy System:
> Accelerating deployment of smart technologies in all areas and phases of energy development to improve sustainable self-adaptability. Speeding up construction of smart grids, improving two-way response among grids, generation and customer-side systems, to adapt to development of distributed generation and multiple needs from consumers. Promoting deep integration of energy and information technologies, planning construction of energy, communication and transportation infrastructure networks as a whole, building energy internet with "generation", "grid", "load" and "storage" integrated and complementary with each other and developing coordinately.

(ch. 30, § 3).

89. 12th FYP, *supra* note 17, ch. 10, § 1.

90. 12th FYP, *supra* note 17, ch. 10, § 3.

91. 12th FYP, *supra* note 17, ch. 11, § 3; 12th FYP on Energy Development, *supra* note 17, ch. 3, § 4; 12th FYP on National Energy Science and Technology, *supra* note 35; Strategic Action Plan on Energy Development, *supra* note 26.

92. 12th FYP, *supra* note 17, ch. 11, § 3; 12th FYP on Energy Development, *supra* note 17, ch. 3, § 3; 12th FYP on National Energy Science and Technology, *supra* note 35; Strategic Action Plan on Energy Development, *supra* note 26.

93. Strategic Action Plan on Energy Development, *supra* note 26.

transmission and localized distributed generation should be developed simultaneously.[94]

In order to meet the smart grid target set by the 12th FYP, the plans outline major technologies to facilitate the smart grid development, which need to be promoted and policies, which need to be adopted.

With respect to technologies, the main points are improving the integration of new energy generation, distributed energy, and electric vehicles to the grid; implementing interactive communication between the electricity system and consumers; promoting upgrades to different parts of power grids; improving the security and efficiency of power grids; and providing opportunities to develop smart-grid-related industries.[95]

The government also calls for strengthening the planning and standardization of smart grid technologies. It points toward the establishment of policy mechanisms to accelerate the deployment of smart grid technologies and equipment and to promote micro-grids, smart grid communities, smart buildings, and smart meters. For example, the government urges the adoption of peak and off-peak rates of electricity, demand-side management, energy technology innovation systems, and energy efficiency.[96]

2. Systematic Plans

Smart grid has been identified as a strategic emerging industry and emphasis has been placed on it on several occasions. However, there is no nationwide policy laying out the mechanism for promoting smart grid development. The most relevant discussions are contained in the 12th Five-year Plan on National Energy Science and Technology (2011–2015) by the NEA, the 12th Five-year Specialized Plan on the Industrialization of Key Sciences and Technologies of Smart Grids by MOST, and in the General Plan on Application of Intelligent Technologies to Power Grids by the SGCC.

a. The 12th Five-year Plan on National Energy Science and Technology (2011–2015) (December 5, 2012)

This plan, issued by the NEA covers four key energy technology sectors, namely: exploration and exploitation, processing and transformation, electricity generation and transmission, and new energy. It mainly focuses on technologies, which can be implemented by 2015, but also describes the R&D of certain promising technologies that might provide a breakthrough within ten years. With respect to smart grids, the plan lists technologies for the integration of large-scale intermittent energy, energy storage, and power grid intelligence.[97] The plan also sets a specific R&D target, content, and timeline for each technology.

This plan requires the relevant government bodies to give priority to these technologies in the approval of major energy projects, and calls for the establishment of energy science and technology innovation systems including

94. The Guideline on Promoting Development of Smart Grid, *supra* note 87.

95. 12th FYP on Energy Development, *supra* note 17, ch. 3, § 3.

96. 12th FYP on Energy Development, *supra* note 17, ch. 3, § 3; Strategic Action Plan on Energy Development, *supra* note 26.

97. 12th FYP on National Energy Science and Technology, *supra* note 35.

government departments such as NDRC, NEA, MOST, Ministry of Industry and Information Technology, as well as academic institutions, such as the National Academy of Sciences, and universities.

In order to carry out the R&D of these technologies, the plan takes the approach of identifying specific projects and formulating specific research plans, and recommending that major energy corporations play the leading role in close cooperation with government agencies and academic institutions. The plan also emphasizes improving standards and establishing inspection, accreditation, and quality management systems. The plan is very specific and establishes clear criteria for the realization of listed targets. However, it only highlights a few smart grid technologies.[98]

b. The 12th Five-year Specialized Plan on the Industrialization of Key Sciences and Technologies of Smart Grids (March 27, 2012)

This plan systematically deals with and specializes in smart grid technologies. It aims at promoting the industrialization of key smart grid technologies in China. Its overall targets for smart grids are in line with the general plans, but it includes more details. Specifically speaking, the plan focuses on four aspects: (1) breakthrough and mastery of the key technologies, such as large-scale integration of intermittent new energy to the grid, energy storage, smart distribution and utilization of electricity, smart dispatch and control of a massive power grid, and smart equipment; (2) forming a smart grid technology system with independent intellectual property rights and a system of technology standards; (3) establishing a completed smart grid industrial chain; and (4) constructing automatic, and interactive smart grids, to promote the transition of traditional power grids to more efficient, economical, clean, and interactive modern grids.

The plan highlights eight key technology sectors: (1) large-scale integration of intermittent new energy to the grid; (2) grid technologies supporting the deployment of electric vehicles; (3) energy storage; (4) smart operation and control of a massive power grid; (5) smart transmission and transformation technologies and equipment; (6) information and communication technologies for power grids; (7) flexible power transmission and transformation technologies and equipment; and (8) comprehensive pilot smart grid projects. Under each sector, the plan makes a detailed description of the specific technologies that need to be developed.

In support of the industrialization of these technologies, the plan takes steps in building pilot projects and fostering the relevant industries. It targets twenty to thirty pilot projects for specialized smart grid technologies, three to five comprehensive pilot smart grid projects, five to ten pilot smart grid cities, and fifty pilot smart grid industrial parks. Additionally, it endeavors to drive the development of energy, transportation, manufacturing, material, and information industries, etc.[99]

98. *Id.*

99. 12th FYSP on the Industrialization of Key Sciences and Technologies of Smart Grids, *supra* note 18.

This plan maps out the technological aspects of smart grid utilization. However, the plan recognizes that adoption of smart grid technologies must also be supported by policies offering stakeholders incentives for moving forward to smart grids that might center on demand response and the rate setting for electricity reflecting peak and off-peak differences. According to the plan, to achieve the desired goals without support from these kinds of policies, new technologies are insufficient by themselves.

c. The SGCC General Plan on Application of Intelligent Technologies to Power Grids (March 2010)

The plan of the SGCC was launched before the plans by the NEA and MOST, but is more detailed. In its plan, the SGCC analyzed the *status quo* of the power grid in China, anticipated the trends of grid development and electricity demand, and then set out the principles and targets for its Strong Smart Grid development, followed by a detailed breakdown of the general target. The SGCC divided the power grid into eight sections: generation, transmission, transformation, distribution, utilization, power dispatch, information platform, and others. It broke down the general targets in these sections further. In each section, the plan set a detailed target, road map, technology standard, key equipment (systems), and key projects. It also analyzed the investment performance, social benefits, and influence to the management of the corporation in carrying out this plan. Based on this information, the plan proposed measures to support the realization of targets and raised suggestions for policymaking.[100]

The SGCC plans to move forward to Strong Smart Grid in three steps. The first step is dedicated to planning and testing (2009-2010); the second step is for comprehensively building the Strong Smart Grid (2011-2015); and the third is dedicated to improving the Strong Smart Grid (2016-2020) and completing the building of Strong Smart Grid in China by 2020. The grid of the SGCC will be able to accommodate more than 100GW electricity from wind and 20GW solar photovoltaic generation.[101]

The plan reiterates that "strong" and "smart" are two essential elements of the modern grid, which are integrated with each other and cannot be separated.[102] Thus in this plan, the SGCC covered both aspects.

However, it was not until 2009 that the SGCC first launched the concept of "Strong Smart Grid," before then only the term "strong grid" was used[103]. In line with the concept, the SGCC targeted the investment in Ultra High Voltage transmission lines before 2009. While the power grid was heading toward distributed and micro-grid in other parts of the world, the SGCC's approach of building centralized and long distance transmission lines seemingly went against the trend. Some experts were saying that the government wanted to break down

100. *See generally* GENERAL PLAN, *supra* note 11.

101. *Id.* at 40-46.

102. *Id.* at 34, 35.

103. *Liu Zhenya's Keynote Speech at International Forum of Smart Grids*, *supra* note 12.

the giant electric cooperation into several regional companies.[104] The SGCC's robust steps of building long transmission lines across the country were aimed at connecting the grid system as a whole and making it impossible for the government to separate it.[105] Although this might be one of the reasons, the imbalanced spread of power generation sources and electricity demand in China does require the dispatch of electricity in large areas. Most energy resources in China are located in northern and western areas, while power demand centers are largely located in central and eastern China. This requires China to build long grid lines with distances ranging between 1,000 and 3,000 km for the large-scale power transmission in order to realize the allocation of energy resources nationwide.[106]

Many experts think that alternating current Ultra High Voltage transmission technologies are not reliable.[107] If one takes a step back and looks at all these plans as a whole, what emerges is that the "strong" and "smart" components of the grid are and will be developing simultaneously in China. On June 13, 2014, the Central Finance and Economy Leading Group, which is the core authority in economic decision-making in China, confirmed that China would continue to develop long distance and large capacity transmission technologies.[108]

3. The Guideline by the NDRC and NEA

The Guideline on Promoting Development of Smart Grid is of crucial importance.[109] The NDRC and NEA are the regulators of electricity industry. Their Guideline shows the government's current attitude towards the direction of smart grid development, especially since the NDRC and NEA had historically been hesitant to adopt a policy on smart grids on a national level. The Guideline by the NDRC and NEA implies that government agencies and market players have finally come to a compromise.

It is interesting that the NDRC and NEA refer to this document as a "guideline," rather than a "decision," "rule," or "opinion." The author thinks it implies at least three things. First, it means the government wants to adopt a market-oriented way to promote smart grids. As the Guideline says, the government favors markets and encourages diversified investment and finance.[110] This is in line with reform going on in China to transform the planned economy model for the electric industry into a market economy model. Second, because this is the first time the NDRC and NEA have published an official document on the development of the smart grid industry as a whole, they likely are using the Guideline as a means to gauge the response before they pass something further that might have binding effect. Third, a "guideline" is sufficient to show the

104. Liang Zhongrong (梁钟荣), Guojia Dianwang Chaifen zhi Nan: Wuda Quyu Dianwang Yibei Kongkehua (国家电网拆分之难：五大区域电网已被空壳化) [The Difficulties to Splitting the SGCC: The Five Regional Grid Companies Have Becoming Empty Shells], 21 SHIJI JINGJI BAODAO (21 世纪经济报道) [21 CENTURY BUSINESS HERALD (Mar. 20, 2013)], *available at* http://finance.qq.com/a/20130320/001888.htm.

105. *Id.*

106. 12th FYSP on the Industrialization of Key Sciences and Technologies of Smart Grids, *supra* note 18, at 4.

107. Yao Yao, *supra* note 15, at 55.

108. *Id.*

109. The Guideline on Promoting Development of Smart Grid, *supra* note 87.

110. *Id.*

government's preferences. It thereby sends market signals as to what kinds of projects are more likely to be approved by the NDRC and NEA.

The Guideline lays down four principles in the development of smart grids: (1) over-all planning—government needs to draft strategic plans for smart grids to coordinate and stimulate active involvement of grid companies, equipment manufacturers, and consumers; (2) develop both centralized and distributed smart grids; (3) marketization—government should promote markets in allocating resources and encourage social investment; and (4) respect different conditions in various locations across China—encourage localized measures in promoting smart grids.[111]

These principles reveal four signals: (1) there will be a nation-wide plan on smart grids; (2) both strong and smart grids will be supported; (3) market players will not be limited to state-owned enterprises—the government welcomes diversified investment; and (4) the central government will give local governments more power to tailor their own programs.

Based on these principles, the Guideline also sets the targets for smart grid development. China will primarily complete the construction of smart grid system by 2020. This system will be able to integrate a high proportion of clean energy while its reliability will be world-leading. The grid will also be capable of serving the various needs of consumers.[112]

The Guideline raises ten main tasks covering nearly every aspect of smart grids, including application of intelligent technologies on generation side; integration of new energy; interconnection of various energy sources; construction of information communication platforms; safe, reliable and economic operation of power grids; strengthening demand-side management; and improving the standard system. Among the ten tasks, there are three which are not limited to smart grids: (1) calls for using green electric energy to substitute for fossil fuels and realize energy saving; (2) encouraging the use of smart grid as part of building smart cities and new-style urbanization; and (3) emphasizing the importance of key technology and equipment R&D to drive up-stream and down-stream industry development.[113]

The Guideline does not just emphasize the importance of smart grids or just deal with technical questions. In addition to pointing out specific direction and major tasks, it also gives suggestions on how to realize these goals, such as upgrading electricity pricing mechanisms to encourage demand-side involvement.[114]

4. Standardization

Smart grids are comprehensive systems involving generation, transmission, distribution, utilization, power dispatch, and information platforms. They connect the control system of the grid company with sensors and equipment all across the system, including the customer-side systems, such as smart meters, smart appliances, and electric vehicles. Developing standards to increase the

111. *Id.*

112. *Id.*

113. *Id.*

114. The Guideline on Promoting Development of Smart Grid, *supra* note 87.

interoperability of the different components is crucial for the smooth communication and operation of smart grid systems.[115]

The standard system of China includes four different kinds of standards: National standards; Industrial standards; Local standards; and Enterprise standards.[116] International standards also play an important part in the drafting of standards because China is a member of the WTO and complies with the Agreement on Technical Barriers to Trade.[117]

a. Enterprise Standards

The SGCC launched a Plan for Smart Grid Technology Standard System in June 2010. The plan divides standards into eight branches, twenty-six sections, and ninety-two standard series.[118] The SGCC has already published 417 enterprise standards and taken part in the drafting of thirty-seven national standards and 143 industrial standards.[119] The CSG also takes part in standards development, but the SGCC is more influential.[120]

b. Industrial Standards, National Standards, and International Standard Cooperation

In December 2010, the National Smart Grid Standardization Promotion Group (NSGSP) was established under the joint leadership of the NEA and the Standardization Administration of China (SAC).[121] The NSGSP is in charge of the strategic planning of smart grid standardization, guiding the draft and revision of national and industrial standards, coordinating different departments and industries, and promoting the smart grid technology standard system.

There are three sub-groups under the NSGSP: the smart grid standardization group; the smart grid equipment standardization group; and the smart grid standardization international cooperation group. The leaders of these groups are from the China Electricity Council (CEC), the China Electrical Equipment Industrial Association (CEEIA), and the SGCC respectively, with other leaders and group members from various bodies including industrial associations, academic institutions, and companies etc.[122]

115. ENERGY TECH. POLICY DIV., *supra* note 4, at 31-32.

116. Zhonghua Renmin Gongheguo Biaozhunhua Fa (中华人民共和国标准化法) [Standardization Law of the People's Republic of China] (promulgated by the 5th Session of the Standing Comm. of the 7th Nat'l People's Cong., Dec. 29, 1988, effective Apr. 1, 1989), art. 6, *available at* http://www.sac.gov.cn/zwgk/flfg/gnflfg/201012/t20101210_56200.htm.

117. Agreement on Technical Barriers to Trade, art. 2.4, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1, 1868 U.N.T.S. 120.

118. STATE GRID CORP. OF CHINA, ZHINENG DIANWANG JISHU BIAOZHUN TIXI GUIHUA (智能电网技术标准体系规划) [PLAN FOR SMART GRID TECHNOLOGY STANDARD SYSTEM] (June 2010).

119. LIU ZHENYA (刘振亚), QUANQIU NENGYUAN HULIANWANG (全球能源互联网) [GLOBAL ENERGY INTERNET] 311 (Zhongguo Dianli Chubanshe (中国电力出版社) [China Elec. Power Press], Jan. 2015).

120. Matt Lecar, *supra* note 42.

121. Liu Changyi, *Smart Grid Implementation & Standardization in China,* State Grid Corp. of China, KSGW.OR.KR (Nov. 2011), http://www.ksgw.or.kr/ver2011/pdownload.php?p=2&f=6___Changyi%20Liu___Smart%20Grid%20Implementation_Standardization%20in%20China-Mr.Liu%20Changyi.

122. Guojia Nengyuanju Guanyu Chengli Guojia Zhineng Dianwang Biaozhunhua Zongti Gongzuo Tuijinzu de Tongzhi (国家能源局关于成立国家智能电网标准化总体工作推进组的通知) [Notice of the

In 2013, the SAC launched a comprehensive pilot program on the standardization of smart grid technologies. The office is located in the CEC. It sponsors twelve projects and falls under five categories: the integration of new energy sources into the grid; smart transformers; smart dispatch; charging facilities for electric vehicles; and the internationalization of standards.[123]

Traditionally, preparing standards involves a cumulative process—drafting one standard after another. The SAC distinguished this pilot program from the traditional ones because it set a general structure for the standards and has been preparing them simultaneously.[124] The formalization should be completed before March 2016.[125]

The SAC took further steps on May 16, 2014, to strengthen the standardization of smart grid technologies by agreeing to establish two committees: the National Technical Committee 549 on Smart Grid User Interface of Standardization Administration of China and the National Technical Committee 550 on Electric Energy Storage of Standardization Administration of China. These two committees are both branches of the SAC, but the CEC is in charge of their daily management.

China is also actively involved in the preparation of international standards. The International Electrotechnical Commission (IEC) approved the establishment of PC 118 on smart grid user interface in 2011 with its Secretariat placed at the China Electric Power Research Institute (CEPRI) (under the SGCC). It is in charge of "[s]tandardization in the field of information exchange for demand response and in connecting demand side equipment and/or systems into smart grids."[126]

Foreign investors must learn the relevant Chinese standards very carefully and try to get involved in the development of standards. For instance, the U.S. Trade and Development Agency (USTDA) has launched programs on smart grid standardization cooperation between U.S. companies and their counterparts in China.[127]

National Energy Agency on the Establishment of National Smart Grid Standardization Promotion Group (NSGSP)] (promulgated by the NEA, Guoneng Keji [2010]) 334 Hao, Sept. 30, 2010), *available at* http://www.nea.gov.cn/2011-10/12/c_131187554.htm.

123. *Zhineng Dianwang Zonghe Biaozhunhua Shidian Gongzuo Qidonghui Zhaokai* (智能电网综合标准化试点工作启动会召开) [*The Meeting Was Held for Launching the Comprehensive Pilot Program on the Standardization of Smart Grid Technologies*], ZHONGGUO DIANLI QIYE LIANHEHUI (中国电力企业联合会) [CHINA ELEC. COUNCIL] (June 3, 2013), http://dls.cec.org.cn/dongtai/2013-06-03/103279.html.

124. Lü Qinglang (吕晴朗), *Biaozhunhua Jiushi Kexuehua— Dianli Jianshe Biaozhunhua Gongzuo Chixu Tisu* (标准化就是科学化—电力建设标准化工作持续提速) [*Standardization Is a Scientific Approach—the Standardization of Power System Construction Is Accelerating*], CPNN.COM.CN (Apr. 2, 2014), http://www.cpnn.com.cn/zdyw/201404/t20140402_667109.html.

125. *The Meeting Was Held for Launching the Comprehensive Pilot Program on the Standardization of Smart Grid Technologies, supra* note 123.

126. *PC 118 Smart Grid User Interface*, INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC), http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID:8701 (last visited May 27, 2015).

127. Under a USTDA Grant, GE worked with the China Electric Power Research Institute (under State Grid) to develop China's standards for smart grid infrastructure that are appropriate for China and harmonized with U.S. Standards. In cooperation with the NEA, USTDA is funding a series of technical meetings in China between Chinese and U.S. smart grid experts and standards developers to identify and develop common electricity metering standards and draft a roadmap for continued U.S.–China smart grid technical standards harmonization. China's Electrical Equipment Industry Association is working with the National Electrical

B. Integration of Renewable Energy to Grid

The integration of a large amount of renewable and distributed energy resources challenges the operation of the electricity system.[128] Smart grids can help through the automation of controls for generation and demand, demand response, energy storage, electric vehicle charging *et al*, to increase the stability and efficiency of grids and to improve the capability of the grids to dispatch and control electricity.[129]

1. Renewable Energy Integration

According to the Renewable Energy Law of the People's Republic of China[130] and Management Regulations for Electricity Generation from Renewable Energy, [131] grid companies should grant full access to renewable energy generators. [132] Generally speaking, grid companies are responsible for the construction[133] and adaptation[134] of the grid to facilitate access for renewable energy projects as well.[135]

a. Grid Access

The Renewable Energy Law requires that grid companies guarantee the purchase of the full amount of electricity generated by renewable sources.[136] As long as the renewable electricity companies in the coverage area of their power grids: (1) have gone through the administrative licensing or filing; (2) have been constructed according to the Plan for the Development and Utilization of Renewable Energy Resources; and (3) meet the grid connection technical

Manufacturers Association (NEMA) on this project. Geoffrey Jackson, Regional Director, East Asia, Address at the USTDA Webinar: Opening Markets, Generating Exports—U.S. Trade and Development Agency (Feb. 12, 2013).

128. ENERGY TECH. POLICY DIV., *supra* note 4, at 18.

129. *Id.*

130. Zhonghua Renmin Gongheguo Kezaisheng Nengyuan Fa (中华人民共和国可再生能源法) [Renewable Energy Law of People's Republic of China] (promulgated by the 14th Session of the Standing Comm. of the 10th Nat'l People's Cong., Feb. 28, 2005, revised by the 12th Session of the Standing Comm. of the 11th Nat'l People's Cong., Dec. 26, 2009, effective Apr. 1, 2010), *available at* http://www.chinalaw.gov.cn/article/fgkd/xfg/fl/200912/20091200176803.shtml [hereinafter Renewable Energy Law].

131. Guojia Fazhan Gaigewei Guanyu Yinfa "Kezaisheng Nengyuan Fadian Youguan Guanli Guiding" de Tongzhi (国家发展改革委关于印发《可再生能源发电有关管理规定》的通知) [Notice of the NDRC on Issuing "Management Regulations for Electricity Generation from Renewable Energy"] (promulgated by the NDRC, Fagai Nengyuan [2006] 13 Hao, Jan. 5, 2006), *available at* http://bgt.ndrc.gov.cn/zcfb/200602/t20060206_499272.html [hereinafter Management Regulations for Electricity Generation from Renewable Energy].

132. Renewable Energy Law, *supra* note 130, at art. 14; Management Regulations for Electricity Generation from Renewable Energy, *supra* note 131, at art. 11.

133. Renewable Energy Law, *supra* note 130, at art. 14; Management Regulations for Electricity Generation from Renewable Energy, *supra* note 131, at art. 11, art. 12.

134. Renewable Energy Law, *supra* note 130, at art. 14; Management Regulations for Electricity Generation from Renewable Energy, *supra* note 131, at art. 11.

135. ENERGY AND SEC. GRP., *supra* note 40, at 28.

136. Renewable Energy Law, *supra* note 130, at art. 14.

standards, grid companies should conclude grid connection agreements with them.[137]

b. Construction of Interconnection Facility

Grid companies are responsible for the construction and operation of interconnection facilities for the integration of electricity generated from renewables.[138] For the medium- and large-scale renewable energy projects connecting directly to the power transmission lines, such as hydro, wind, and biomass power projects, the grid companies should finance and construct the interconnection facilities. As for those small-scale renewable projects connecting to power distribution lines, generally the grid companies should do the same thing. But power generation companies or individuals can also invest and construct the interconnection facilities after consulting with the grid companies.[139]

Furthermore, the law also requires grid companies to improve the adaptation of grid systems to ensure the full integration of renewables, and expand the area of power dispatching, by improving operation management and developing smart grid and energy storage technologies.[140]

The grid companies at and above the provincial level should draft plans on the construction of interconnection facilities for the integration of electricity generated from renewable energy. Such plans should be approved by the provincial governments and the NDRC, and incorporated into the medium and long-term plan for the development of national and provincial power grids.[141]

2. Feed-in-Tariff

In support of the deployment of renewable energy, China adopted the feed-in-tariff approach. Generally speaking, electricity generated by renewable energy is more expensive than energy from traditional sources like fossil fuels, so in order to level the playing field, the law requires grid companies to buy all the renewables, but at the same time, it compensates the grid companies by surcharging consumers with an extra fee, called a feed-in-tariff.[142]

The feed-in-tariff is used to compensate for the margin between the renewable energy price and the average on-grid price for electricity generated by traditional energy, as well as for other reasonable costs from integrating renewables into grids, such as interconnection costs, which could not be collected through electricity sales.[143]

137. *Id.*

138. Management Regulations for Electricity Generation from Renewable Energy, *supra* note 131, at art. 12.

139. Management Regulations for Electricity Generation from Renewable Energy, *supra* note 131, at art. 12.

140. Renewable Energy Law, *supra* note 130, at art. 14.

141. Management Regulations for Electricity Generation from Renewable Energy, *supra* note 131, at art. 10.

142. Renewable Energy Law, *supra* note 130, at art. 20.

143. There are also some independent public electricity systems run by renewables, which are invested or subsidized by the state, they sell electricity on the rates set for that location. The reasonable operation and management costs exceeding the income from sale of electricity could be compensated too. Caizhengbu, Guojia Fazhan Gaigewei, Guojia Nengyuanju, Guanyu Yinfa "Kezaisheng Nengyuan Fazhan Jijin Zhengshou Shiyong

The curtailment of wind and solar power in China is still serious. In 2014, the average rate of curtailment of wind power national wide is 8%, which is the lowest in recent years. However, some areas are worse such as in Xinjiang and Jilin where the rates are as high as 15%.[144] An investigation carried out by MOST showed that the curtailment of solar power by photovoltaic plants reached 40% in 2013.[145] Lack of coordination between the building of renewable energy generation projects and improvement of the grid systems to accommodate these intermittent energies has jeopardized the healthy development of renewables.[146]

C. Distributed Generation

Distributed generation refers to power generation facilities which are constructed or installed in or near the sites where users are located.[147] It includes small hydro, wind, solar, biomass, ocean, geothermal energy, *et al* that are directly connected to power distribution lines.[148] The primary purpose of the generation is to serve local end users, with extra power sold to the grid companies.

Most power generation today is centralized. While distributed generation is not a substitute for this model, it is believed that it could increase the stability of the grid by providing more options and flexibility. Distributed generation can also promote the use of renewable energy and get more consumers involved in the deployment of green energy.[149]

Distributed generation is closely related to the smart grid because smart grid technology is issued directly or indirectly with distributed generation, such as system control and power dispatch, smart meters, and demand response. The

Guanli Zanxing Banfa" de Tongzhi (财政部、国家发展改革委、国家能源局, 关于印发《可再生能源发展基金征收使用管理暂行办法》的通知) [Notice of the Ministry of Finance (MOF), NDRC and NEA on Issuing "Provisional Measures on the Collecting and Utilization of Renewable Energy Development Fund"] (promulgated by the MOF, NDRC and NEA, Caizong [2011] 115 Hao, Nov. 29, 2011, effective Jan. 1, 2012), art. 14, *available at* http://zhs.mof.gov.cn/zhengwuxinxi/zhengcefabu/201112/t20111212_614767.html. Guojia Fazhan Gaigewei Guanyu Tiaozheng Kezaisheng Nengyuan Dianjia Fujia Biaozhun yu Huanbao Dianjia Youguan Shixiang de Tongzhi (国家发展改革委关于调整可再生能源电价附加标准与环保电价有关事项的通知) [Notice of the NDRC on Issues related to Adjustment of the Standard of Renewable Energy Feed-in-Tariff and Environmental Protection Electricity Price] (promulgated by the NDRC, Fagai Jiage [2013] 1651 Hao, Aug. 27, 2013, effective Sept. 25, 2013), *available at* http://www.sdpc.gov.cn/fzgggz/jggl/jggs/201308/t20130830_556164.html.

144. 2014 Nian Fengdian Chanye Jiance Qingkuang (2014 年风电产业监测情况) [Supervision over the Wind Industry of 2014], NAT'L ENERGY ADMIN. (Feb. 12, 2015), http://www.nea.gov.cn/2015-02/12/c_133989991.htm.

145. Luan Xiangke (栾相科), *Niuzhuan Qifeng Qiguang, Gongjice Xu Duoxia Gongfu* (扭转弃风弃光,供给侧须多下工夫) [*Supply Side Should Be Strengthened in Order to Reduce the Curtailment of Wind and Solar Power*], Zhongguo Zhanlue Xinxing Chanye (中国战略新兴产业) [CHINA STRATEGIC EMERGING INDUS.] 56, 56 (Sept. 15, 2014).

146. *Id.*

147. Fazhan Gaige Wei Guanyu Yinfa "Fenbushi Fadian Guanli Zanxing Banfa" de Tongzhi (发展改革委关于印发《分布式发电管理暂行办法》的通知) [Notice of the National Development and Reform Comm'n (NDRC) on Issuing "Provisional Measures on the Management of Distributed Electricity Generation"] (promulgated by NDRC, Fagai Nengyuan [2013] 1381 Hao, July 18, 2013), art. 2, *available at* http://zfxxgk.nea.gov.cn/auto87/201308/t20130814_1692.htm [hereinafter Provisional Measures on the Management of Distributed Electricity Generation].

148. *Id.* at art. 3.

149. Kristin Bluvas, *Distributed Generation: A Step Forward in United States Energy Policy*, 70 ALB. L. REV. 1589, 1600-1604 (2006-2007).

NDRC encourages constructing smart grids and micro grids in combination with the application of distributed generation, in order to improve efficiency and the safe and steady operation of distributed generation.[150]

The Chinese government highly values the development of distributed generation. Indeed, the 12th FYP, the 12th Five-year Plan on Energy Development, the Strategic Action Plan on Energy Development (2014–2020), MOST's, and SGCC's Plan all cite distributed generation as a key development area.

1. Market Access

The NDRC encourages enterprises, specialized energy service companies, and various kinds of electricity users, including individuals to invest, construct, and operate distributed generation projects. NDRC also exempts distributed generation projects from business licenses for power generation.[151]

Since power generation has been open to private investment for a long time, the NDRC's policy is not unexpected. What needs to be noted is that the SGCC announced in May 2014 that it opened up to social capital: (1) the interconnection projects of distributed generation to grids; and (2) charging and battery changing facilities for electric vehicles. This is the first time that the SGCC has allowed social capital to invest in the power grid systems.[152] Although this announcement was criticized because it only opened some marginal business to the market, it was good news for the development of distributed generation and electric vehicles. This policy was reinforced by the State Council's Guidelines on Innovating the Investment and Finance Mechanism in Key Areas to Encourage Social Investment.[153]

2. Grid Access

Electricity generated by the distributed facilities is primarily for self-use; extra power (if there is any) goes into grids. Grid companies are required to give priority access and purchase all the extra power uploaded from distributed generation.

The electricity is measured by dual direction (consuming and generating) or in net amount (consuming minus generating), and can take into consideration the

150. Provisional Measures on the Management of Distributed Electricity Generation, *supra* note 147, at art. 18.

151. *Id.* at art. 12.

152. Wang Bingning (王冰凝), Guojia Dianwang "Songkou", Fangkai Fenbushi Nengyuan Youliyu Jiejue Tegaoya Anquan (国家电网"松口", 放开分布式能源有利于解决特高压安全) [SGCC Opening Market of Distributed Generation Is Good for Solving the Safety Problems of Ultra High Voltage Transmission], CHINA TIMES (May 30, 2014, 21:24), http://www.chinatimes.cc/hxsb/news/gongsi/140530/1405302124-135661.html.

153. Guowuyuan Guanyu Chuangxin Zhongdian Lingyu Tourongzi Jizhi Guli Shehui Touzi de Zhidao Yijian (国务院关于创新重点领域投融资机制鼓励社会投资的指导意见) [Guidelines of the State Council on Innovating the Investment and Finance Mechanism in Key Areas to Encourage Social Investment] (promulgated by the State Council, Guofa [2014] 60 Hao, Nov. 16, 2014), *available at* http://www.gov.cn/zhengce/content/2014-11/26/content_9260.htm [hereinafter Guidelines of the State Council to Encourage Social Investment].

peak and off-peak price for electricity.[154] The realization of these mechanisms largely relies on smart meters. The SGCC has provided detailed instruction on the integration of distributed generation.[155]

3. Incentives

The Chinese government offers two kinds of subsidies to distributed generation: one grants funding for the construction of distributed generation projects, the other subsidizes the electricity generated by the projects. Only one kind of subsidy can be granted for each project.[156]

As for photovoltaic distributed generation, all the electricity generated by the project is granted a RMB0.42/Kwh (tax included) subsidy to the owners. The extra electricity uploaded into the grid is paid by the grid companies at the price for on-grid electricity generated by coal-fired power plants.[157] In addition, photovoltaic distributed generation is also exempted from several charges[158] and enjoys financial support from the China Development Bank.[159]

D. Electric Vehicle Charging Infrastructure

The Chinese government encourages the development of pure electric vehicles over hybrids.[160] The government has published a series of policies to

154. Provisional Measures on the Management of Distributed Electricity Generation, *supra* note 147, at art. 21.

155. Guojia Dianwang (国家电网) [SGCC], Guanyu Zuohao Fenbushi Guangfu Fadian Bingwang Fuwu Gongzuo de Yijian (Zanxing) (关于做好分布式光伏发电并网服务工作的意见(暂行)) [Opinions on Facilitating the Service for Interconnecting Distributed Photovoltaic Generation to Power Grid (Provisional)] (Oct. 2012); Guanyu Cujin Fenbushi Guanfu Fadian Bingwang Guanli Gongzuo de Yijian (Zanxing) (关于促进分布式光伏发电并网管理工作的意见(暂行)) [Opinions on Promoting the Management of Interconnecting Distributed Photovoltaic Generation to Power Grid (Provisional)] (Oct. 2012); Fenbushi Guangfu Jieru Peidianwang Jishu Guiding (Zanxing) (分布式光伏发电接入配电网技术规定(暂行)) [Technology Provisions on Interconnecting Distributed Photovoltaic Generation to Power Grid (Provisional)] (Oct. 2012); Guanyu Zuohao Fenbushi Dianyuan Bingwang Fuwu Gongzuo de Yijian (关于做好分布式电源并网服务工作的意见) [Opinions on Facilitating the Service for Interconnecting Distributed Generation to Power Grid] (Mar. 2013).

156. Provisional Measures on the Management of Distributed Electricity Generation, *supra* note 147, at art. 27.

157. Guojia Fazhan Gaigewei Guanyu Fahui Jiage Ganggan Zuoyong Cujin Guangfu Chanye Jiankang Fazhan de Tongzhi (国家发展改革委关于发挥价格杠杆作用促进光伏产业健康发展的通知) [Notice of the NDRC on Facilitating the Rule of Price to Promote the Healthy Development of Photovoltaic Industry] (promulgated by the NDRC, Fagai Jiage [2013] 1638 Hao, Aug. 26, 2013), http://www.sdpc.gov.cn/zwfwzx/zfdj/jggg/201308/t20130830_556127.html.

158. *Id.*

159. Guanyu Zhichi Fenbushi Guangfu Fadian Jinrong Fuwu de Yijian (关于支持分布式光伏发电金融服务的意见) [Opinions on Financial Services for Supporting Distributed Photovoltaic Generation] (promulgated by NEA and China Development Bank, Guoneng Xinneng [2013] 312 Hao, August 22, 2013), *available at* http://www.nea.gov.cn/2014-09/04/c_133620586.htm.

160. Guowuyuan Bangongting Guanyu Jiakuai Xinnengyuan Qiche Tuiguang Yingyong de Yijian (国务院办公厅关于加快新能源汽车推广应用的指导意见) [Guidelines of the General Office of the State Council on Accelerating the Deployment of New Energy Vehicles] (promulgated by the General Office of the State Council, Guobanfa [2014] 35 Hao, July 14, 2014), *available at* http://www.gov.cn/zhengce/content/2014-07/21/content_8936.htm [hereinafter Guidelines of the General Office of the State Council on Accelerating the Deployment of New Energy Vehicles].

stimulate the development of electric vehicles in China,[161] putting forward many incentives to encourage the research, production, and purchasing of electric vehicles.

Insufficient charging facilities have hindered the deployment of electric vehicles. In 2014, the General Office of State Council formulated the Guidelines on Accelerating the Deployment of New Energy Vehicles requesting acceleration in building charging facilities and raising supportive measures such as plan and standard setting, landing, pricing, and technology research.[162] The Guidelines also clarify that the government will provide financial awards for developing electric vehicle charging facilities to cities, which promote electric vehicles on a large scale.[163] The NDRC has also published a notice clarifying the rules and incentives on electricity rates for electric vehicle charging.[164] The SGCC announced in May 2014 that it was open to private capital for charging facilities for electric vehicles. The effect of these various policies remains to be seen.

E. Demand Side Management

Traditionally, the power grid is a system without energy storage. Once electricity has been generated, it must be used instantaneously. Therefore, the grid is designed to meet the peak demand and grid companies must have sufficient stand-by resources on hand, which may not be used for most of the time. They not only increase the cost of grid operation, but also result in wasting natural resources.[165] Demand side management encourages end users to reduce energy consumption, increase efficiency, and shift their consumption to off-peak times.[166]

Almost all the government's general plans—such as the 12th FYP, the Strategic Action Plan on Energy Development（2014-2020), and the 12th Five-year Plan on Energy Development—emphasized the importance of demand-side management and the government's desire to promote it. Demand side management is an important measure for achieving energy conservation and meeting emission reduction targets. As early as the end of 2010, six government agencies[167] jointly published the Measures for the Electricity Demand Side Management, which lays out the basic mechanism for demand side management.

161. Xinnengyuan Qiche Shengchan Zhunru Guanli Guize (新能源汽车生产准入管理规则) [Admittance Management Rules on New Energy Vehicles] (promulgated by the NDRC, Oct. 17, 2007, effective Nov. 1, 2007), *available at* http://bgt.ndrc.gov.cn/zcfb/200710/t20071023_500205.html.

162. *See generally* Guidelines of the General Office of the State Council on Accelerating the Deployment of New Energy Vehicles, *supra* note 160.

163. *Id.*

164. Guojia Fazhan Gaigewei Guanyu Diandong Qiche Yongdian Jiage Zhengce Youguan Wenti de Tongzhi (国家发展改革委关于电动汽车用电价格政策有关问题的通知) [Notice of the NDRC on Issues Concerning the Electricity Pricing Policies for Electric Vehicles] (promulgated by the NDRC, Fagai Jiage [2014] 1668 Hao, July 22, 2014), *available at* http://jgs.ndrc.gov.cn/zcfg/201408/t20140801_621052.html [hereinafter Notice of the NDRC on Issues Concerning the Electricity Pricing Policies for Electric Vehicles].

165. Pedram Samadi et al., *The Role of Demand Side Management*, INST. OF ELEC. AND ELECTRONICS ENG'RS (IEEE), http://smartgrid.ieee.org/october-2011/418-the-role-of-demand-side-management (last visited May 27, 2015).

166. *Id.*

167. The National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Finance, the State-owned Assets Supervision and Administration Commission, the State Electricity Regulatory Commission, and the National Energy Administration.

The NDRC is in charge of the demand side management nationwide; with the cooperation of other relevant departments of the State Council.[168] Provincial electricity operation administration departments are required to set up plans, annual targets, and implementation programs for demand side management.[169] Grid companies are expected to provide technical support and information services for consumers in demand side management.[170] In order to support the adoption of demand side management, the government also calls for the promotion of peak and off-peak power pricing, off-peak energy storage, seasonal power pricing, etc.[171]

The government also arranges funds to support demand side management. The funds are primarily used for the construction, operation, and maintenance of the electricity load management system, for the subsidization of pilot, model, and key projects, and for the electricity demand control subsidies and relevant publicity, training, and assessment expenses.[172] Grid companies can include reasonable demand side management expenses into their cost bases.[173]

The central government has also set up a special fund to offer rewards to pilot cities for demand side management.[174] The supporting scope of the incentive fund includes: (1) establishment of the electricity service management platform; (2) implementation of energy-efficient power plants; (3) promotion for the technology of moving peak loads to fill valley loads, and development of the response of electricity demand; and (4) among other things, the relevant scientific research, publicity, training, examination, and evaluation.[175]

In addition, in order to promote an inverted rate (with higher rates for usage over a base level)[176] and time-of-use pricing (peak and off-peak prices are different), the government requires every household to have its own independent meter.[177] This policy also boosts the installation of smart meters in China.

168. Guanyu Yinfa "Dianli Xuqiuce Guanli Banfa" de Tongzhi (关于印发《电力需求侧管理办法》的通知) [Notice on Issuing "Measures on Administration of Electricity Demand Side Management"] (promulgated by NDRC, Fagai Yunxing [2010] 2643 Hao, Nov. 4, 2010, effective Jan. 1, 2011), art. 5, http://www.gov.cn/zwgk/2010-11/16/content_1746514.htm.

169. *Id.* at art. 9.

170. *Id.* at art. 13.

171. *Id.* at art. 11.

172. *Id.* at art. 23.

173. Guanyu Yinfa "Dianli Xuqiuce Guanli Banfa" de Tongzhi (关于印发《电力需求侧管理办法》的通知) [Notice on Issuing "Measures on Administration of Electricity Demand Side Management"] (promulgated by NDRC, Fagai Yunxing [2010] 2643 Hao, Nov. 4, 2010, effective Jan. 1, 2011), art. 24.

174. Caizhengbu, Fazhan Gaigewei Guanyu Yinfa "Dianli Xuqiuce Guanli Chengshi Zonghe Shidian Gongzuo Zhongyang Caizheng Jiangli Zijin Guanli Zanxing Banfa" (财政部、发展改革委关于印发《电力需求侧管理城市综合试点工作中央财政奖励资金管理暂行办法》的通知) [Notice of the MOF and NDRC on Issuing "Provisional Measures on the Administration of Central Government Reward Fund for Comprehensive Pilot Cities for Demand Side Management"] (promulgated by the MOF and NDRC, July 3, 2012, Caijian [2012] 367 Hao), *available at* http://www.mof.gov.cn/mofhome/ningxia/lanmudaohang/zhengcefagui/201207/t20120731_670512.html.

175. *Id.* at art. 6.

176. REGULATORY ASSISTANCE PROJECT, ELECTRICITY REGULATION IN THE US: A GUIDE 51 (2011), *available at* http://www.raponline.org/docs/RAP_Lazar_ElectricityRegulationInTheUS_Guide_2011_03.pdf.

177. Guojia Fazhan Gaigewei Guanyu Wanshan Jumin Jieti Dianjia Zhidu de Tongzhi (国家发展改革委关于完善居民阶梯电价制度的通知) [Notice of the NDRC on Improving the Inverted Rate Mechanism for Residential Customers] (promulgated by NDRC, Fagai Jiage [2013] 2523 Hao, Dec. 11, 2013), *available at*

V. MARKET ACCESS OF FOREIGN DIRECT INVESTMENT (FDI) IN THE SMART GRID INDUSTRY AND INCENTIVES

Instead of pursuing a quantitative increase in FDI, the central government of China has been endeavoring to increase the quality of FDI by optimizing the priority areas of investment. The smart grid industry may fall into several categories of the priority areas for FDI, such as high technology, energy saving, and new energy.[178] However, the power grid industry is traditionally under the strict control of state-owned enterprises and is still subject to the planned economy model.[179] After President Xi Jinping took office, he carried out reform in the electricity industry to build a more market-oriented mechanism.[180] FDI in smart-grid-related industries has been granted greater market access and incentives. Meanwhile, the Chinese government is trying to shift the FDI from the coastal areas to central, western, and northern parts of the country. Some of these places explicitly list smart-grid-related sectors as a preferential industry.

A. Market Access of FDI in the Smart Grid Industry

Smart grids are comprehensive systems, which include electricity machinery and equipment, information technology, material science, and energy service. For the purpose of discussing market access of FDI in China's smart grid industry, this article divides the smart grid industry into two major sectors: one concerns the construction and operation of power grids; the other involves the manufacture of equipment and service for grids. Traditionally, state-owned enterprises dominated the construction and operation of power grids while in general, the manufacture of equipment and service for grids has been open to all kinds of investors.[181]

The Foreign Investment Industrial Guidance Catalogues (the Catalogue) issued by the NDRC and Ministry of Commerce prescribe whether foreign investment in a particular industry or service is encouraged, restricted, or forbidden in China.

The Chinese government revises the Catalogue periodically according to the priorities of industrial development (originally adopted in 1997, and revised in 2002, 2005, 2007, 2011, and 2015).[182] The latest revision entered into force on April 10, 2015.[183]

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http://jgs.ndrc.gov.cn/zcfg/201401/t20140102_574319.html [hereinafter Notice of the NDRC on Improving the Inverted Rate Mechanism for Residential Customers].

178. 12th FYP, *supra* note 17.

179. Qiu & Li, *supra* note 6.

180. *Xi Jinping: Actively Promoting the Revolution for Energy Production and Consumption*, *supra* note 7.

181. Special licenses or certificates from the government may be needed.

182. Ken Davies, *China Investment Policy: An Update* 28 (Org. Econ. Co-operation and Dev. Working Papers on International Investment 2013/01), *available at* http://dx.doi.org/10.1787/5k469l1hmvbt-en.

183. Waishang Touzi Chanye Zhidao Mulu (2015 Xiuding) (外商投资产业指导目录(2015 年修订))[Foreign Investment Industrial Guidance Catalogue (2015 Revision)] (promulgated by the NDRC and Ministry of Commerce [MOFCOM], Zhonghua Renming Gongheguo Guojia Fazhan Gaige Weiyuanhui, Zhonghua Renmin Gongheguo Shangwubu Ling Di 22 Hao, Mar. 10, 2015, effective Apr. 10, 2015), *available at* http://www.sdpc.gov.cn/gzdt/201503/t20150313_667334.html [hereinafter Foreign Investment Industrial Guidance Catalogue (2015 Revision)].

The Catalogue divides foreign investment industries into encouraged, restricted, and prohibited categories.[184] Beside the industrial sectors, in some cases the Catalogue also put limits on the form of the foreign investment or the share it can hold in the enterprise.[185] Industrial sectors that are not listed are deemed permitted.[186]

1. Construction and Operation of Power Grids

The construction and operation of electric vehicle charging and battery changing facilities is encouraged both under Catalogue 2011[187] and 2015.[188] Investment in the construction and operation of power grids fell under the restricted category in Catalogue 2011.[189] But in Catalogue 2015, investment in the construction and operation of power grids has been moved from "restricted" to "encouraged," although a Chinese party must hold a controlling interest.[190] This is a significant step forward related to the market-oriented reform in the energy field and the changing of attitudes towards private investment domestically.

As previously noted, in May 2014, the SGCC announced that it would open two market areas to social investment: one is the interconnection of distributed generation, and the other concerns charging and battery changing facilities. While this is the first time that the SGCC has allowed social investment in its markets, it has been criticized for opening only two non-core business sectors.[191]

The State Council took further steps to lift restrictions by releasing the Guidelines on Innovating the Investment and Finance Mechanism in Key Areas to Encourage Social Investment in November 2014.[192] The Guidelines encourage social capital to take part in the construction of power grids, especially in the investment and construction of cross-regional electricity transmission lines, the improvement projects for regional trunk electricity transmission lines, and electricity distribution lines for medium and large cities. The Guidelines list two pilot transmission line projects and they re-emphasize that social capital is encouraged to invest in the interconnection project for distributed generation, energy storage, and the charging and battery changing facilities for electric vehicles.[193]

184. Zhidao Waishang Touzi Fangxiang Guiding (指导外商投资方向规定) [Provisions on Guiding the Orientation of Foreign Investment] (promulgated by the State Council of China, Zhonghua Renmin Gongheguo Guowuyuan Ling Di 346 Hao, Zhonghua Renmin Gongheguo Guowuyuan Ling Di 346 Hao, Feb. 11, 2002, effective Apr. 1, 2002), art. 4, *available at* http://www.gov.cn/gongbao/content/2002/content_61969.htm.

185. *Id.* at art. 8.

186. *Id.* at art. 4.

187. Waishang Touzi Chanye Zhidao Mulu (2011 Xiuding) (外商投资产业指导目录(2011 年修订))[Foreign Investment Industrial Guidance Catalogue (2011 Revision)] (promulgated by the NDRC and MOFCOM, Zhonghua Renming Gongheguo Guojia Fazhan Gaige Weiyuanhui, Zhonghua Renmin Gongheguo Shangwubu Ling Di 12 Hao, Dec. 24, 2011, effective Jan. 30, 2012), *available at* http://www.gov.cn/gongbao/content/2012/content_2144287.htm [hereinafter Foreign Investment Industrial Guidance Catalogue (2011 Revision)].

188. Foreign Investment Industrial Guidance Catalogue (2015 Revision), *supra* note 183.

189. Foreign Investment Industrial Guidance Catalogue (2011 Revision), *supra* note 187.

190. Foreign Investment Industrial Guidance Catalogue (2015 Revision), *supra* note 183.

191. Wang Bingning, *supra* note 152.

192. *See generally* Guidelines of the State Council to Encourage Social Investment, *supra* note 153.

193. *See generally id.*

These policies suggest a promising future for foreign investment. However, investors should not be overly optimistic. First, although Catalogue 2015 encourages the investment in the construction and operation of power grids, the Guidelines on Innovating the Investment and Finance Mechanism in Key Areas to Encourage Social Investment only encourage investment in the construction of some parts of power grids, without mentioning their operation. Second, these policies are all very general. And there is much uncertainty on how these policies would be carried out. According to Han Shui, head of the electricity division of NEA, the pilot projects would be open to social investment, however state-owned enterprises would hold the controlling share.[194]

2. Manufacture and Service Related to Smart Grids

In contrast to the construction and operation of power grids, laws and policies on the manufacture of smart grid equipment and appliances and service to grids are better developed and more transparent. In Catalogue 2011, the investment in manufacturing of power transmission and transformation equipment was encouraged, but needed to be in the form[195] of equity or contractual joint ventures,[196] whereas in Catalogue 2015, the limitation on the form of enterprises has been lifted.[197] There are also several other items in the encouraged category relating to smart grids, such as the manufacture of high-precision digital volt meters and ampere meters (with a span of seven and a half bits or more), development and production of software products, energy saving and environmental protection technology development and services, research and development centers, high and new technologies, new product development, and enterprise incubation centers, internet of things technology development, and application. Furthermore, there is no apparent restriction or prohibition on manufacturing and service related to smart grids.[198] Thus, foreign investment in smart grids-related manufacturing and service is generally allowed and in some areas is being encouraged.

The growing smart grid market in China has already attracted a lot of foreign companies. ABB (China) and Guodian Nanjing Automation Co. Ltd. launched a

194. Yu Huapeng (于华鹏), *Nengyuanju Guanyuan: Choubei Hedian he Dianwang Jianshe Yinru Shehui Ziben* (能源局官员：筹备核电和电网建设引入社会资本) [*Officials from NEA: Preparing for the Introduction of Social Investment to the Construction of Nuclear Power Plants and Power Grids*], JINGJI GUANCHA WANG (经济观察网) [EEO.COM.CN] (Dec. 4, 2014), http://www.eeo.com.cn/2014/1204/269627.shtml.

195. There are three organizational structures available to foreign-invested enterprises, including equity joint venture, contractual joint venture, and wholly foreign-owned enterprise. MOFCOM published Foreign Investment Law of the People's Republic of China (Exposure Draft) on January 19, 2015. It abolishes the three-way division of foreign-invested enterprises. All foreign-invested enterprises would be treated the same. However, this is just a draft and it is hard to know whether and when it could be passed by the legislative body. *Shangwubu Jiu "Zhonghua Renmin Gongheguo Waiguo Touzi Fa (Caoan Zhengqiu Yijian Gao) Gongkai Zhengqiu Yijian"* (商务部就《中华人民共和国外国投资法（草案征求意见稿）》公开征求意见) [*MOFCOM Solicits Opinions from the General Public on Foreign Investment Law of the People's Republic of China (Exposure Draft)*], MOFCOM (Jan. 19, 2015), *available at* http://tfs.mofcom.gov.cn/article/as/201501/20150100871010.shtml.

196. *See generally* Foreign Investment Industrial Guidance Catalogue (2011 Revision), *supra* note 187.

197. *See generally* Foreign Investment Industrial Guidance Catalogue (2015 Revision), *supra* note 183.

198. *See generally id.*

joint venture, Yangzhou SAC Switchgear Co. Ltd,[199] manufacturing equipment for smart grids.[200] Other joint ventures, such as Echelon's partnership with China's Holley Metering and eMeter and Siemens' partnership with Wasion are making inroads into Chinese smart meter projects.[201]

3. National Security Review

It is important to note that, if foreign investors enter the Chinese market by merging or acquiring a domestic enterprise or by any other means participating in the concentration of business operators, they will be subject to examination on the investment concentration. Furthermore, when national security is involved, examination of potential national security issues will also be conducted.[202]

Because smart grids involve infrastructure and electricity supply, they may be subject to a national security examination as prescribed by the Notice of the General Office of the State Council on the Establishment of the Security Review System for Mergers and Acquisitions of Domestic Enterprises by Foreign Investors. These inquiries include situations such as foreign investors' mergers and acquisitions of enterprises surrounding major and sensitive military facilities, and other entities relating to national defense security; foreign investors' mergers and acquisitions of domestic enterprises relating to important energy and natural resources; important infrastructure facilities; important transportation services; key technologies; manufacture of major equipment, which relate to national security, and whose actual controlling power may be obtained by foreign investors.[203] The national security review mechanism was formally established in 2011, the government has not disclosed how many cases have been reviewed and how those rules have been applied.

199. *Our Company*, *supra* note 44.

200. *ABB yu Guodian Nanzi Hezi Chengli Yangzhou Guodian Nanzi Kaiguan Youxian Gongsi* (ABB 与国电南自合资成立扬州国电南自开关有限公司) [*ABB (China) Limited and Guodian Nanjing Automation Co., Ltd Created a joint venture Yangzhou SAC Switchgear Co., Ltd.*], ZHONGGUO DIANLI WANG (中国电力网) [CHINA POWER.COM.CN] (Sept. 2, 2011), http://www.chinapower.com.cn/article/1188/art1188450.asp.

201. St. John, *supra* note 5.

202. Zhonghua Renmin Gongheguo Fanlongduan Fa (中华人民共和国反垄断法) [Anti-Monopoly Law of the People's Republic of China] (promulgated by the 29th Session of the Standing Comm. of the 10th Nat'l People's Cong., Aug. 30, 2007, effective Aug. 1, 2008), art. 31, *available at* http://www.gov.cn/flfg/2007-08/30/content_732591.htm.

203. Guowuyuan Bangongting Guanyu Jianli Waiguo Touzizhe Binggou Jingnei Qiye Anquan Shencha Zhidu de Tongzhi (国务院办公厅关于建立外国投资者并购境内企业安全审查制度的通知) [Notice of the General Office of the State Council on the Establishment of the Security Review System for Mergers and Acquisitions of Domestic Enterprises by Foreign Investors] (promulgated by the General Office of the State Council, Guobanfa [2011] 6 Hao, Feb. 3, 2011), art. 1.1, *available at* http://www.gov.cn/zwgk/2011-02/12/content_1802467.htm.

B. Incentives Available for FDI in the Smart Grid Industry

There are several incentives available for foreign investment in smart-grid-related industries, such as exemption from customs duties,[204] tax reduction,[205] and support from national scientific development projects and innovation capacity cultivation projects.[206] But these incentives may fall under different categories. For example, incentives for encouraged foreign investment,[207] strategic emerging industries,[208] high and new technology industries,[209] and establishing research centers.[210] Since these incentives are generally applicable to investments falling into those categories and are not limited to smart-grid-related industries, they have already been widely analyzed in the available scholarship.[211] Hence, this article will not review them.

In order to boost foreign investment in central, western, and northern China, the NDRC and Ministry of Commerce published the Catalogue of Priority Industries for Foreign Investment in Central and Western China (2013 Revision).[212] This Catalogue includes industrial sectors, which are related to smart grids. In particular, the Catalogue lists "smart grid equipment" in the Xinjiang Uygur Autonomous Region; "manufacture of grid intelligent management and controlling system equipment" in Heilongjiang Province; and "large scale energy storage technology research and development, manufacture,

204. Haiguan Zongshu Gonggao 2008 Nian 103 Hao (海关总署公告 2008 年 103 号) [Notice of the General Administration of Customs of the People's Republic of China, No. 103, 2008] (promulgated by the General Admin. of Customs of China, Dec. 31, 2008, effective Jan. 1, 2009), *available at* http://www.customs.gov.cn/publish/portal0/tab1/info154122.htm; Guowuyuan Guanyu Tiaozheng Jinkou Shebei Shuishou Zhengce de Tongzhi (国务院关于调整进口设备税收政策的通知) [Notice of the State Council on Adjusting the Tariff and Taxation Policy on Imported Equipment] (promulgated by the State Council, Guofa [1997] 37 Hao, Dec. 29, 1997, effective Jan. 1, 1998), *available at* http://www.jl.gov.cn/bsfw/bsyj_wsbs/201009/t20100913_789424.html; ZHONGGUO TOUZI ZHINAN (中国投资指南) [GUIDANCE ON INVESTMENT IN CHINA] 14 (CHINA COMMERCE AND TRADE PRESS, 2014), *available at* http://img.project.fdi.gov.cn//21/1800000121/File/201409/20140919044827199 7199.pdf.

205. GUIDANCE ON INVESTMENT IN CHINA，*supra* note 204, at 21.

206. Guowuyuan Guanyu Jinyibu Zuohao Liyong Waizi Gongzuo de Ruogan Yijian (国务院关于进一步做好利用外资工作的若干意见) [Several Opinions on Further Utilizing Foreign Capital] (promulgated by the State Council, Guofa [2010] 9 Hao, Apr. 6, 2010), *available at* http://www.gov.cn/zwgk/2010-04/13/content_1579732.htm [hereinafter Several Opinions on Further Utilizing Foreign Capital].

207. *Id.*

208. Guowuyuan Guanyu Jiakuai Peiyu he Fazhan Zhanluexing Xinxing Chanye de Jueding (国务院关于加快培育和发展战略性新兴产业的决定) [Decision of the State Council on Accelerating the Cultivation and Development of Strategic Emerging Industries] (promulgated by the State Council, Guofa [2010] 32 Hao, Oct. 10, 2010), *available at* http://www.gov.cn/zwgk/2010-10/18/content_1724848.htm.

209. Several Opinions on Further Utilizing Foreign Capital, *supra* note 206.

210. *Id.*

211. Davies, *supra* note 182; GUIDANCE ON INVESTMENT IN CHINA, *supra* note 204; JAMES M. ZIMMERMAN, ESQ., CHINA LAW DESKBOOK: A LEGAL GUIDE FOR FOREIGN-INVESTED ENTERPRISES (A.B.A eds., 4th ed. 2014).

212. Zhongxibu Diqu Waishang Touzi Youshi Chanye Mulu (2013 Nian Xiuding) (中西部地区外商投资优势产业目录 (2013 年修订)) [Catalogue of Priority Industries for Foreign Investment in Central and Western China (Revised in 2013)] (promulgated by the NDRC and MOFCOM, Zhonghua Renming Gongheguo Guojia Fazhan Gaige Weiyuanhui, Zhonghua Renming Gongheguo Shangwubu Ling Di 1 Hao, May 9, 2013, effective June 10, 2013), *available a*t http://www.sdpc.gov.cn/zcfb/zcfbl/201305/t20130516_541505.html (other than central and western areas, the Catalogue covers larger geographic areas including northeast China).

and application" in Inner Mongolia Autonomous Region, Liaoning Province, and Sichuan Province.[213]

In addition, various local governments are promoting the development of the smart grid industry, such as Zhongyuan Electrical Valley in Henan Province, the Smart Grid R&D Industrial Base of the SGCC in Nanjing, Smart Grid Industry Park in Yangzhou,[214] and Smart Grid Industrial Base in Pearl River Delta.[215]

VI. CHALLENGES FOR FDI IN THE SMART GRID INDUSTRY

While the Chinese market offers tremendous opportunities, policy uncertainties resulting from ongoing reforms, lack of comprehensive regulation over the smart grid industry, changing pricing rules for electricity, and concerns on intellectual property protection all create challenges for FDI in the smart grid industry.[216]

A. Policy Uncertainty Resulting from Reform of Electricity Regulation

The smart grid industry includes different aspects of power grids, ranging from the integration of renewables on the generation side, to the control and maintenance of the power transmission and distribution side, and finally to consumer side appliances such as smart meters and distributed generation—and everything in-between. Therefore, the market for smart grid products and services is closely related to the electricity regulatory mechanism as a whole.

China's power sector is undergoing a major reform from a government regulated, vertically integrated, state-owned monopoly to an unbundled, market-oriented industry.[217] However, the reform has encountered tremendous obstacles ever since it was launched in 2002, when the State Council published the Program for Electric Power Mechanism Reform.[218] Although more than ten years have passed, only the generation sector has been separated from the vertical monopoly.

After President Xi Jinping took office, power sector regulatory reform was raised again. On June 13, 2014, President Xi Jinping called for an energy revolution; he said China should create effective competition in energy transactions and a market-based pricing mechanism.[219] One of the focuses of this revolution in the power sector is to break the monopoly of state-owned enterprises, leaving power generation and sale to market competition, with grid companies

213. *Id.*

214. Jiang Fang & Tao Liuyi (蒋芳 & 陶鎏怡), *Yangzhou Chengwei Guojia Zhineng Dianwang Tese Chanye Jidi* (扬州成为国家智能电网特色产业基地) [*Yangzhou Became the National Industrial Base Specializing in Smart Grids*], XINHUANET.COM (Aug. 12, 2010), http://www.js.xinhuanet.com/xin_wen_zhong_xin/2010-08/12/content_20606864.htm.

215. *Zhongguo Zhineng Dianwang Chanye Jiju Guihua Xianzhuang yu Fazhan Qushi Fenxi* (中国智能电网产业集聚规划现状与发展趋势分析) [*Analysis on the Status Quo and Trend of Development of Smart Grid Industry Concentration and Planning in China*], STATE GRID CORP. OF CHINA (Mar. 2, 2012), *available at* http://www.sgcc.com.cn/ztzl/newzndw/cyfz/03/267878.shtml.

216. The author analyzes the challenges from the perspective of smart grid regulation; so economic challenges or other common challenges FDI generally faces would not be discussed here.

217. REGULATORY ASSISTANCE PROJECT, *supra* note 69.

218. Program on Electric Mechanism Reform, *supra* note 68.

219. *Xi Jinping: Actively Promoting the Revolution for Energy Production and Consumption*, *supra* note 7.

only in charge of providing power transmission and distribution service, which is a natural monopoly industry. However, there were different opinions on how to realize this transition; one of the most influential opinions suggested to separate distribution property from the grid companies and to establish independent power selling companies.[220]

The March 15, 2015, Several Opinions of the Communist Party of China Central Committee and State Council on Further Strengthening Reform on Power Mechanism ("the Opinion") is the key document carrying out this reform. The Opinion did not adopt the approach of splitting grid companies. Although it has been criticized for being conservative, it introduces some groundbreaking measures, such as terminating the era of state-owned grid companies dominating the sale of power, and opening up the electricity selling market to social capital. Meanwhile, it calls for the building of an electricity transaction market and relatively independent power transaction agencies; encourages large electricity consumers to buy power directly from power generators; grid companies only to charge for the service of power transmission and distribution; encourages development of demand side management and demand response; provides for equal access interconnection to the grid; and introduces new mechanisms to facilitate distributed generation.[221]

The Opinion also gives grid companies confidence that they will not be split, at least not in the near future, so that they can make investment plans on smart grids, especially on the distribution and customer sides.

However, the Opinion also creates a number of uncertainties. First, social investment in the sale of electricity is a new development in China and how it will affect the electricity market remains a question. If the newly established power selling entities earn revenue from the amount of power they sell, they will have no incentive to introduce smart grid technologies to increase efficiency. Second, permitting direct transactions between power generators and consumers allows consumers to find the cheapest power source and electricity generated from fossil fuels is more competitive then renewables. This puts renewable energy at a disadvantage and could also affect the grid companies' incentives to use smart grid technologies to increase the capacity of grids to accommodate renewables. Third, for consumers, there is a lot to take in concerning the changing landscape of power purchasing, the increase of distributed generation, and the promotion of demand side management and demand response. In the past, usage was as simple as turning the on and off switches. How long will it take for consumers to sort through and accept these complexities and the increased cost of installing smart appliances?

220. Xin Diangai Miju (新电改迷局) [*The Puzzles of the New Round of Power Reform*], ZHONGGUO JINGYING WANG (中国经营网) [CB.COM.CN] (Sept. 16, 2014), http://www.cb.com.cn/index.php?m=content&c=index&a=show&catid=20&id=1083873&all.

221. Zhonggong Zhongyang Guowuyuan Guanyu Jinyibu Shenhua Dianli Tizhi Gaige de Ruogan Yijian (中共中央国务院关于进一步深化电力体制改革的若干意见) [Several Opinions of the Communist Party of China Central Committee and State Council on Further Strengthening Reform on Power Mechanisms] (promulgated by the Communist Party of China [CPC] Central Comm., Zhongfa [2015] Di 9 Hao, Mar. 15, 2015) [hereinafter Further Strengthening Reform on Power Mechanisms].

The NDRC published six supporting documents[222] on November 26, 2015, to carry out the reform raised in the Opinion. While two of them mention giving priority to the connection of clean energy to grids,[223] they do not provide solutions to the dilemma of free market competition and high-cost, but environmental-friendly, clean energy. With regard to stimulating the consumption of clean energy, the U.S. also faces a similar dilemma and tries to adjust regulated utilities' amount-based profit model. Unlike the U.S., where there are mature free markets for electricity transactions, China is at the very beginning of trying to create such a market. The Opinion and its six supporting documents provide a blueprint for this market. But the government does not seem to have a strong desire to address the details of the problem at present.

Furthermore, Chinese President Xi Jinping calls for establishing a Global Energy Internet to meet global power demand with clean and green energy.[224] According to Liu Zhenya, Chairman of SGCC, the Global Energy Internet will be a worldwide power grid connecting wind farms in North Pole areas, solar panels in equatorial regions, and large-scale renewable bases in different continents, with major power consuming areas.[225] Building of Global Energy Internet provides a promising way to cope with the intermittency of renewable energy, and presents some appealing opportunities. Meanwhile, it still faces not only technology challenges but also policy uncertainties. The government is carrying out electric power regulation reform domestically, there will be a long way to go before it is ready to open the grid system to power generations outside China on a regular basis.

In sum, the lack of detailed and practical rules on foreign investment, the revising of Electric Power Law, and the uncertain process of legislation in Energy Law all pose legal and policy risks to investment.

These uncertainties will not be resolved in the short term. However, this also means that there will be many opportunities, especially for energy service companies. In a market in transition, both large grid companies and consumers will need expert advice.

B. Absence of Systematic Policies to Promote Smart Grid Development

As discussed in Part III, China has developed several policies to promote smart grids and the increasing investment in smart grids indicates that these policies are on the right track. However, a detailed review of these policies shows that they are far from enough. The general policies, which relate to smart grids have set out the strategic targets, but the plans dealing with smart grids specifically mainly focus on smart grid technologies. In some cases smart grid technologies'

222. Supporting Documents on the Electric Power Mechanism Reform, *supra* note 78.

223. *Id.* at apps. 2, 4.

224. *Towards a Mutually Beneficial Partnership for Sustainable Development,* CHINA.ORG.CN (Nov. 4, 2015), http://www.china.org.cn/china/2015-11/04/content_36975003.htm.

225. LIU, *supra* note 119, at 205.

benefits are nearly assured. But in most cases they can only be realized if combined with smarter policies.[226]

Despite the controversy over Ultra High Voltage transmission, the SGCC is committed to the development of Strong Smart Grid, and continues to invest huge amounts of money into the building of Ultra High Voltage transmission lines. The disparity among stakeholders hinders the systematic policymaking on smart grids.[227]

Incentives currently available mainly fall under the categories of renewable energy integration, distributed generation, electric vehicles, and demand side management. These are all crucial aspects of smart grids. Policies are not coordinated, however, and the development of smart grids requires coordination between these different parts. The increase of large-scale intermittent renewables and distributed generation creates new challenges to the grids. For example, solar energy reaches its peak at noon and cannot produce electricity at night when the system peak demand comes. Electric vehicles could serve as energy storage facilities when people charge their cars at off-peak times. Demand side management also helps to shave peak demand and increases the stability of grid systems. Smart grids are comprehensive systems, which need the cooperation of different parts. Moreover, as smart grids involve the flow of information between consumers and grid companies, information security and protection of privacy can be a significant problem.

The government has realized these problems. As described in Part III, in July 2015, the NDRC and NEA published The Guideline on Promoting Development of Smart Grid, which is a significant step forward. While the Guideline covers a wide range of issues, it is more in the nature of a document showing the government's standpoints on smart grids. The Guideline puts "over-all planning" as the first basic principle to be followed in smart grid development. Significantly, it also points out that a strategic plan should be drafted to coordinate and stimulate active involvement of grid companies, equipment manufacturers, and consumers.[228]

C. Transitioning Electricity Pricing Mechanism

Electricity pricing mechanisms are the basis for the introduction of proper incentives for smart grids. For example, smart meters, which are an important part of smart grids, enable consumers to adjust their activities. Smart grids can show the real time prices for electricity and communicate with the grid companies, thereby cutting down on the use of electricity at peak times when electricity prices are high. In the past, there was no time-of-use pricing of electricity, and consumers had no incentive to cut their consumption during peak time.

226. Lisa Schwartz, *Smart Policies Before Smart Grids: How State Regulators Can Steer Investments Toward Customer-Side Solutions*, REG. ASSISTANCE PROJECT (Aug. 2010), http://raponline.org/docs/RAP_Schwartz_SmartGrid_ACEEE_paper_2010_08_23.pdf.

227. Li Qiyan (李其谚), Zhongguo Zhineng Dianwang Fazhan Fangxiang Zhengyi Youcun (中国智能电网发展方向争议犹存) [There are Still Controversies over the Development Direction of Smart Grids in China], Caijing Wang (财经网) [CAIJING.COM.CN] (June 13, 2009), http://www.caijing.com.cn/2009-06-13/110183821.html.

228. The Guideline on Promoting Development of Smart Grid, *supra* note 87.

The pricing mechanism in China has been undergoing reform from the planned economy model to a market-oriented approach. The target set by the central government is to leave generation and retail prices to market competition, while the government sets power transmission and distribution prices. However, thirteen years have passed since this target was first raised in 2002, and the pricing mechanism reform has not been realized yet. Currently, generation prices and the retail prices are almost all set by the NDRC, under an extremely complicated pricing mechanism. Specifically, there are two issues in pricing mechanisms which are closely related to smart grids. One involves reforming transmission and distribution prices, the other is the gradual adoption of time-of-use pricing.

In the past, there were no independent transmission and distribution prices. The government only set the on-grid generation price and retail price. The gap between retail prices and on-grid generation prices covered transmission, distribution, and the remaining, non-generation functions of the grid companies.[229]

This mechanism has long been criticized. Because grid companies monopolized power purchasing and retailing, the target of the central government was to separate the transmission and distribution from the sale of power. Grid companies would only be in charge of providing transmission and distribution services. This means that power producers and consumers could make deals directly based on competitive market rules.

At the end of 2014, NDRC launched a pilot program in Shenzhen, called the Shenzhen Power Transmission and Distribution Pricing Reform Pilot Program. The pilot period runs from January 1, 2015 to December 31, 2017.[230] The government set the transmission and distribution prices based on allowed cost, allowed profit, and tax.[231] The prices per Kwh are classified in four categories according to different transmission voltages and do not vary from different locations and transmission distances.[232] In January 2015, it was reported that NDRC had approved another Power Transmission and Distribution Pricing Reform Pilot Program in the Inner Mongolia Autonomous Region,[233] followed by five other Provinces.[234]

This approach has been reaffirmed by the Several Opinions of the Communist Party of China Central Committee and State Council on Further Strengthening Reform on Power Mechanism.[235] But the transmission and distribution price only applies to situations where the power is purchased through direct transaction or open bidding. For other purchases, and for residential, agriculture, important public utilities, and public interest services customers, the government will still set electricity prices.[236]

229. REGULATORY ASSISTANCE PROJECT, *supra* note 69, at 12.

230. Notice of the NDRC on Launching a Pilot Project on Power Transmission and Distribution Price Reform in Shenzhen, *supra* note 79.

231. Allowed Income = Allowed Cost + Allowed Benefits + Taxes. *Id.*

232. *Id.*

233. Inner Mongolia Autonomous Region Became the Second Pilot Area in China for Power Transmission and Distribution Price Reform, *supra* note 79.

234. Supporting Documents on the Electric Power Mechanism Reform, *supra* note 78.

235. Further Strengthening Reform on Power Mechanism, *supra* note 221.

236. *Id.*

If grid companies and independent power sellers profit from charging service fees per Kwh, they will have no incentive to take part in reducing power consumption. If they are paid on a fixed basis, they will be reluctant to make new investments in smart grids and to take intermittent renewables which would increase the cost of grid operation. These problems call for further regulation to promote renewable energy and energy saving.

On the consumer side, where the government sets the retail price, the inverted rate design is being introduced, and time-of-use prices are also being adopted in more and more places in China, such as Beijing, Tianjin, Shanghai, Hebei, Guangdong, Jiangsu, Shandong, and Shanxi. On December 11, 2013, NDRC called for the adoption of time-of-use prices for residential electricity across China, requiring all areas to publish their own policies before the end of 2015. The time-of-use price is optional for residents and the government encourages them to take part in peak shaving.[237] In order to carry out the inverted rate and time-of-use prices, the government requires every household to have its own independent meter.[238] This administrative order is an important reason that the number of smart meters installed in China is growing rapidly. Furthermore, the government has also published a notice setting the rules for electricity pricing for electric vehicle charging in which NDRC clarified that electric vehicle charging facilities will follow the time-of-use price.[239] These policies undoubtedly lay down the basis for the adoption of smart grid appliances on the consumer side.

D. Concerns on Intellectual Property Protection

Intellectual property (IP) protection is a major concern for foreign investors in high-tech sectors.[240] China's IP protection generally has a bad reputation, but closer examination of IP protection in the clean technology sector reveals a different picture.

Dr. Kelly Sims Gallagher conducted a systematic research on IP infringement in clean energy technology transfer from foreign IP holders to China.[241] She found that on one hand, foreign firms take intellectual property protection of cleaner energy technologies as a significant business challenge; on the other hand, "there are surprisingly few instances of devastating intellectual property infringement in China in the clean energy sector."[242] She further concluded that intellectual property right infringement also occurs in other parts of the world and therefore it is reasonable to assume that China is not "particularly special" with respect to clean energy intellectual property protection.[243] Another author researching

237. Notice of the NDRC on Improving the Inverted Rate Mechanism for Residential Customers, *supra* note 177.

238. *Id.*

239. Notice of the NDRC on Issues Concerning the Electricity Pricing Policies for Electric Vehicles, *supra* note 164.

240. Davies, *supra* note 182, at 32.

241. KELLY SIMS GALLAGHER, THE GLOBALIZATION OF CLEAN ENERGY TECHNOLOGY: LESSONS FROM CHINA (MIT Press ed., 2014).

242. *Id.* at 114.

243. *Id.* at 116.

"intellectual property rights and renewable energy technology transfer in China" reached a similar conclusion.[244]

In the clean energy sector, the risks may have been overemphasized; at least there are some ways to deal with it. To protect their technology, some investors separate the production process into different physical locations so that employees are unable to know the complete technology process.[245] But the unique characteristics of the power grid industry in China may call for more close cooperation with local partners. As power grid construction and operation is largely in the hands of a few companies, lack of government and business relations may limit the commercial operation. Finding a strong and trustworthy Chinese partner might be a good approach. On one hand it has more power to safeguard IP rights, on the other hand foreign investors could use the mature channels of raw material supply and product sale to facilitate their business operations in China.

VII. CONCLUSION

As the largest electricity consumer in the world, China suffers from serious environmental pollution from the system of energy supply dominated by fossil fuel. Smart grid, as a significant approach to accommodate intermittent renewable energy, increase efficiency, and cultivate energy saving, is treated as a prioritized industry in China. Government agencies like NEA and MOST have published plans on smart grid technologies and grid companies have drafted their own plans as well. Policies are spread over a lot of different documents, covering fields like the integration of renewable energy into power grids, distributed generation, charging facilities for electric vehicles, and demand side management. The NDRC also requires local governments to set rules on time-of-use pricing for electricity. These policies all are intended to stimulate the development of the smart grid industry. The NDRC and NEA took a significant step forward in July 2015 and published The Guideline on Promoting Development of Smart Grid, covering many aspects on smart grids and clarifying the Chinese government's standpoints toward smart grids.

As the largest grid company in China, the SGCC serves more than 1.1 billion people over about 88% of the area of China. This is equivalent to more than three times the population of the United States being served by only one utility company. The industry is vertically integrated and grid companies control the transmission, distribution, and sale of electricity. The market-oriented reform hopes to break the vertical monopoly, leaving the sale of electricity to market competition, with grid companies only in charge of transmission and distribution.

But this reform is ongoing. There is much uncertainty in the regulation of power grids. Along with this reform, the government is opening up the construction and operation of power grids, which used to be dominated by state-owned enterprises. In Catalogue 2015, the government makes it clear that foreign investment is encouraged in this field (the Chinese party must hold a controlling interest). But the absence of detailed rules could bar investors from getting

244. Kiel Downey, *Intellectual Property Rights and Renewable Energy Technology Transfer in China*, 9 S.C. J. INT'L L. & BUS. 89, 123 (2012-2013).

245. GALLAGHER, *supra* note 241, at 111.

involved. By contrast, rules on investment in manufacturing smart-grid-related goods and services are better developed.

While the Chinese market offers tremendous opportunities, intellectual property protection remains an enormous concern for foreign investors. In consideration of all the risks and the unique nature of the power grid industry in China, finding a trustworthy Chinese partner seems to be a reasonable approach.

In sum, after a close examination of the regulatory system, the author finds that, although the power grid industry is still under reform and facing many challenges, there are many opportunities for FDI to get involved and incentives that foreign investment can utilize to promote their smart grid business development in China.